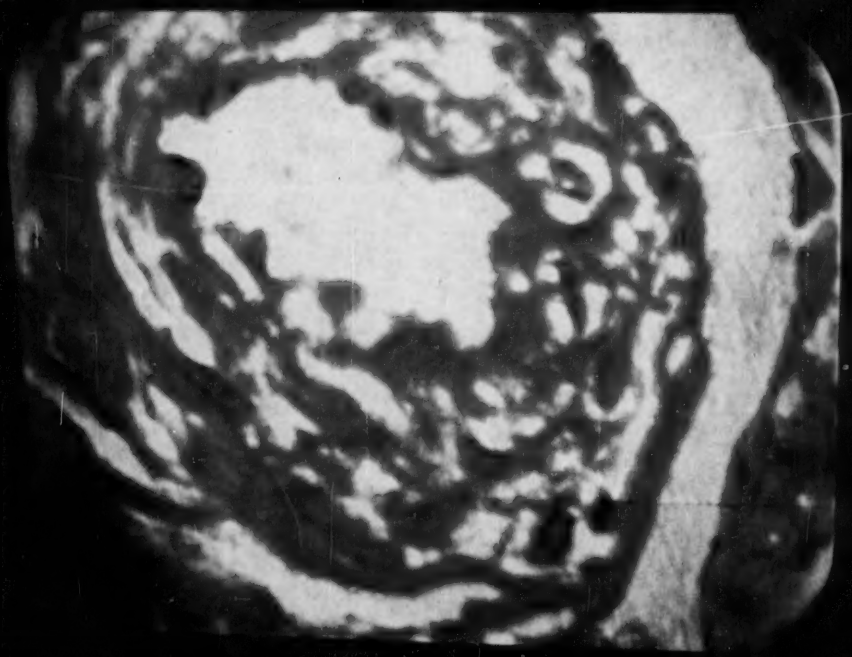
electronics

DECEMBER · 1955



HOW ACCURATE ARE RADAR SPEED METERS?

page 132

New Module Technique 218

Plants of the Future 348

CANCER DIAGNOSIS SPEEDED BY COLOR TV MICROSCOPE

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Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight .8 oz.

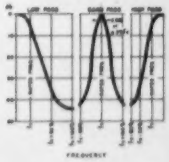
TYPICAL ITEMS

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS

UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 – 2-1/2 high . . . Weight 6-9 oz.

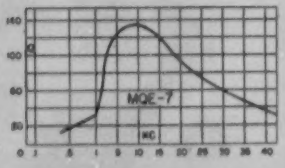


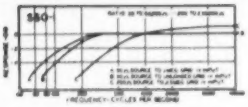
HERMETIC MINIATURE HI-Q TOROIDS

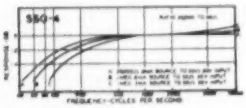
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2







SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weight 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

* Impedance ratio is fixed, 1250:1 for SSO-1,1:50 for SSO-3.
Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

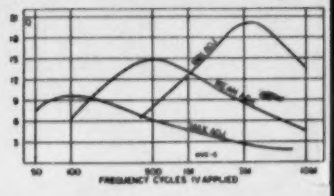
Type No.	Application	Pri. Imp	Sec. Imp
O-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
O-4	Single plate to 1 grid	15,000	60,000
O-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
O-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
O-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
O-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
O-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		

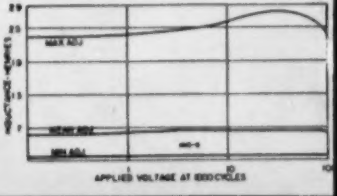
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5





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DECEMBER • 1955

CANCER DIAGNOSIS SPEEDED BY COLOR TV MICROSCOPE—Cancerous tissue is shown magnified 7,500 times on screen by electronic color microscope developed by CBS Laboratories to aid in medical and industrial research (see p 176) ..... COVER

SHOPTALK 2

FIGURES OF THE MONTH 6

INDUSTRY REPORT 7

Aerial Inspection Goes Robot 7
Color TV Warms Up For Takeoff 7
More Small Computers Appear 8
Electronics Gains In Atomics 8
Industry Plans More Spending 10
Wrist Radio Uses Transistors 10
Home Cooking Goes Microwave 12
Small Business Gains More Work 12
FCC Looks At TV Competition 14
Gear Withstands Blast 14
Operations Research Gains 14
Personal Paging Business Advances 16
High-Fidelity Hits the Road 16
Transistors Gain In The Military 20
Why Television Sets Are Failing 20
Tube Machinery Sales Stack Up 22
Research Heads For Billion Mark 22
Subminiature Relay Business 24
Electronics Grows In Business 24
Television Girds For New Markets 24
Civil Defense Fosters Sales 26
Set Prices Go Up 26
Glass Makes Headway In Resistors 26
Financial Roundup 28
Future Meetings 28
Industry Shorts 28
Annual Index 30

CROSSTALK 121

FEATURES

Basic Control Circuits Are Packaged 122
By L. S. Klivans

Designing Over-Horizon Communications Links 126
By David Davidson and Alfred J. Pote

How Accurate Are Radar Speed Meters? 132
By James Q. Brantley, Jr.

Multichannel Switch for Biological Observations 135
By Robert W. Woods

Automatic Colorimeter Checks TV Color Tubes 138
By Emil Sanford

Ice Detector for Lighter-Than-Air Craft 142
By E. G. Thurston

Transmission Gain Set 145
By Gerald R. Chinski

Dielectric Transformers for X-Band Waveguide 146
By Irwin D. Olin

Precision Digital Delay Generator 148
By William Perzley

CONTINUED ON NEXT PAGE

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contents

continued

High-Quality Receiver for TV Rebroadcasting 152
By Raymond S. Rosenberg

Sawtooth Pulser Gives Voltage-Current Curves 156
By N. Sclar and R. L. McFolin

Wide-Band Amplifier for UHF Receivers 158
By Richard B. McWhirt

Audio-Standard Generator 161
By Peter Koustos

Expanded-Scale Voltmeter for A-C Measurements 164
By Herbert Galman

Staggered Triple Crystal Filter 166
By D. E. Hildreth

VHF Transmission Line Calculator 168
By A. E. Sanderson

Annual Index, Volume 28 434

ELECTRONS AT WORK 172

Over-Horizon Radio Links 172
Sensitive Thyratron Relay 172
Japanese Transistor Receiver 174
Flat-Top Communications 174
The Front Cover 176
Digital Voltage Divider 176
Air-Conditioned Shielded Room 180
Zener-Voltage Breakdown Uses 182
Reflection-Type Waveguide 192
Radar Movie 198
Testing UHF DX 200
Zero Hysteresis Relays 202
Light Beam Control 204
Volscan Evaluation 206
Triode-Connected Pentodes 208
Faster Radiosonde 208
Radio Opens Garage Door 212
One-Man TV Camera Aligner 214

PRODUCTION TECHNIQUES 218

New Plug-In Module Assemblies 218
Toothpick Screwdrivers for Cores 222
Router Cuts Wiring Boards 224
One-Way Pallet-Return Conveyor 224
Double-Dip Soldering 226
Modular Etched-Wiring Bundles 230
Dip-Soldering Clamp 242
Automatic Tester for Ferrite Cores 244
Mounting Color TV Picture Tube 246
Eyelets in Etched Wiring 250
Grounding Wiring Boards 256
Tools Added to Wire Cutter 258
Producing Curved Etched Wiring 262
Locating Heater Shorts 264

NEW PRODUCTS 266

LITERATURE 331

PLANTS AND PEOPLE 348

NEW BOOKS 376

THUMNAIL REVIEWS 379

BACKTALK 380

INDEX TO ADVERTISERS 428

SHOP

▶**CAREER . . .** One of the things that helps ELECTRONICS maintain its unique position in the field is the magazine's receptivity to ideas suggested by readers. A surprising number of presumably busy men volunteer topic and treatment suggestions and, in so doing, exhibit considerable publishing flair.

There is an opportunity for one such man to turn pro; we're looking for an editorial staffer. As you would expect, the job requires an engineer with industry experience. Reporting, writing or editing knowhow would represent plus value.

Take a look at the names on our page 1 masthead back over the years and it will be obvious that many of us like our work, our paper and our company very much indeed. There is nothing like an editing career for the right man, nothing tougher for the wrong.

If you think you are the right man write the editor.

▶**ATOMIC READERS . . .** At the Hanford atomic plant, more than 75,000 copies of 800 different magazines are circulated annually among General Electric personnel.

An estimated 1,500 of the 9,200 people on the payroll receive one or more weekly or monthly publications.

Of the 10 magazines most in demand by Hanford people on regular circulation lists, 4 are published by McGraw-Hill; *Nucleonics, Busi-*

electronics

DECEMBER, 1955 Vol. 28, No. 12

Member ABC and ABP

TALK

ness Week, Today's Secretary and ELECTRONICS. The latter is the only one in its field in the top 10.

▶ **DX AID** . . . The problem we had of obtaining a certain 1951 issue (Shoptalk, May '55) brought in a number of suggestions from readers. One of these is from L. van Zeyl of Pretoria, South Africa. He did some research into photocopying equipment and found that there is at least one machine that reproduces book or magazine pages, even though curved, without harming the binding.

▶ **MOVING TORQUE** . . . We met recently a friend of a friend of ours, Harold Varley, an electronics engineer with one of the large firms in the business. He told us of a problem he had several years ago when he was transferred to a West Coast branch.

At that time he had ten years, 120 copies, of ELECTRONICS which provided him with reference material. The bulk and weight of these brought up two problems, convincing his wife that the issues were really going with them, and the problem of packing them for a cross-country trip.

The trucker refused to take the first packing because of excess weight per package. This meant a complete repacking of all the boxes and barrels and redistributing the 120 copies with a few issues in each box and barrel. Each was then filled with lighter items from the household.

EDITORS and engineers often dream of a vocational environment like this one but few achieve it. The staff shares this shop pin-up with readers; it's the headquarters of Technical Marketing Associates, Inc., Concord, Massachusetts

Everything reached the West Coast in good order, fortunately. We didn't mention it to Harold, but suppose he now wanted to move east; his number of copies is now nearly doubled.

▶ **DESK PROBLEM** . . . Engaged in a research project, a visiting engineer commented that our Industry Report each month provides him with much useful data.

His boss, however, is quite a stickler for maintaining clear desk tops. Our friend goes along with this completely for most of the material he handles. But his present assignment requires keeping a dozen or more open copies of ELECTRONICS on his desk top for ready reference at all times.

What to do?

▶ **ANNUAL INDEX** . . . Industry Report articles are indexed cumulatively for the first time on p 30 of this issue. This step has been prompted by the number of telephone calls we get like this:

Voice on phone: "I read something on rising design costs in your magazine. What issue was it in?"

Editor (after a mad scramble through back issues: "That article was in Industry Report, for April."

Voice: "In Industry Report! No wonder I couldn't locate it in the general index."

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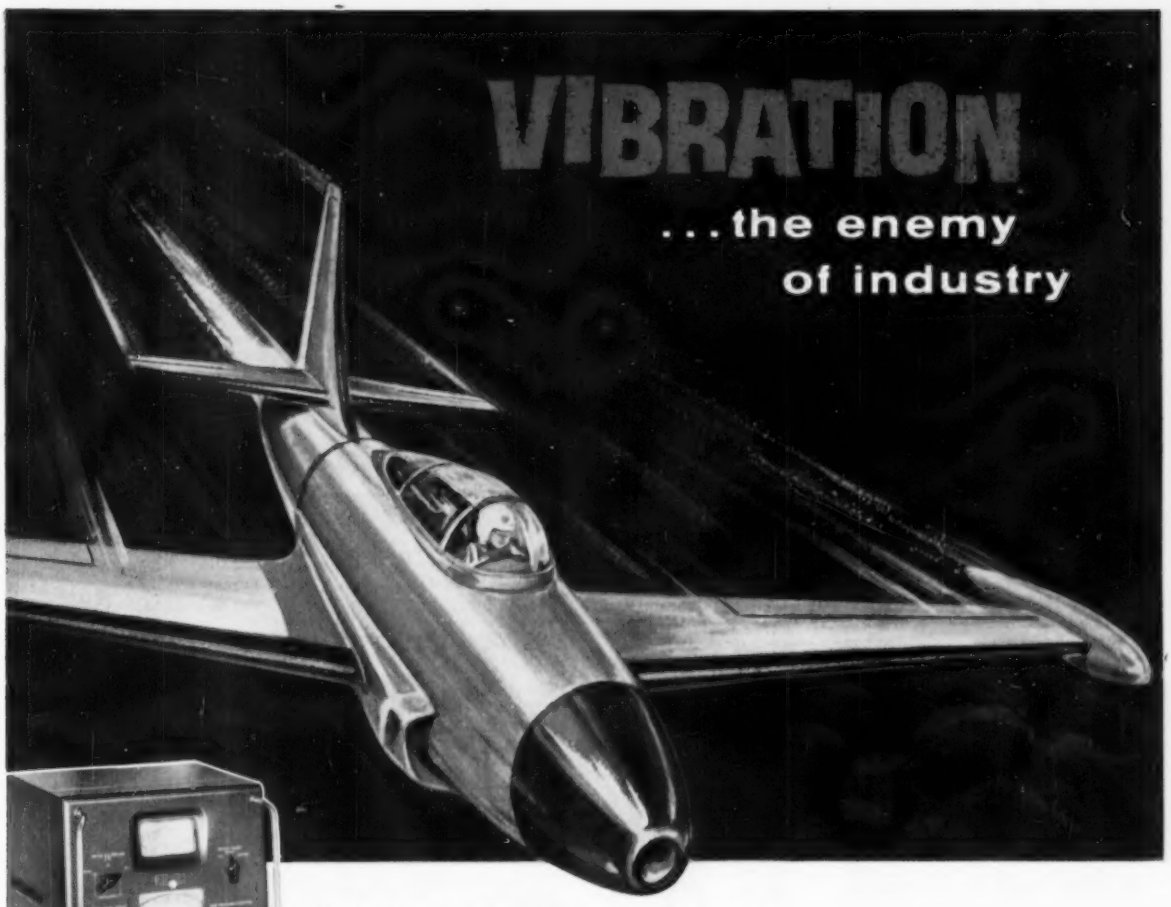

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- R/C-tuned circuits—reduces hum and noise pickup
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- High selectivity characteristic (1% bandwidth for greatest discrimination)
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- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
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- Measurement Accuracy—± 0.3% over most of range
- Output Voltage—10 v
- Input Voltage—1 mv to 300 v rms (FSD)
- Input Impedance—0.1 megohms
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- Power Supply (external)—100/120 v, 60 or 400 cycles, 130 w
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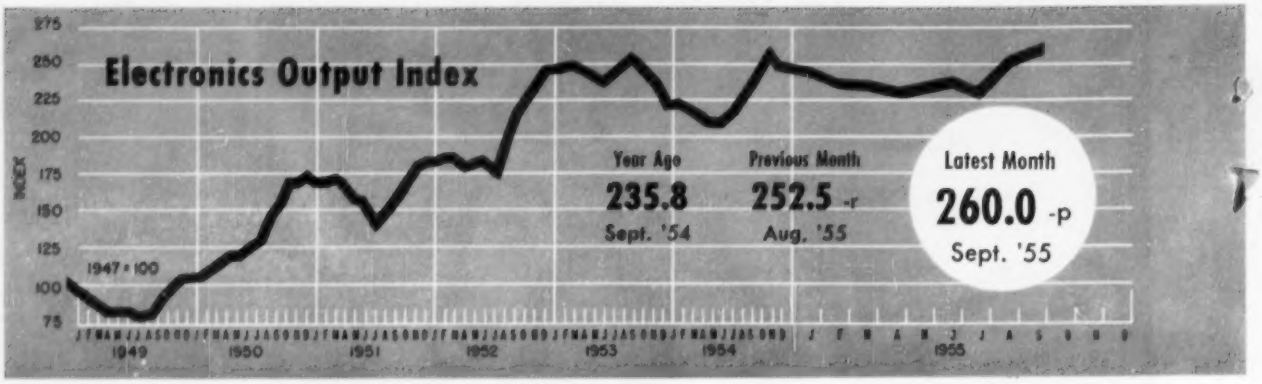


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
Television sets, total	939,515	647,903	947,796
With UHF	140,022	105,673	136,613
Color sets	nr	nr	nr
Radio sets, total	1,302,350	947,634	932,323
With F-M	27,313	13,172	17,644
Home sets	417,802	300,513	352,499
Clock radios	234,106	137,604	207,226
Portable sets	139,164	106,197	76,271
Auto sets	511,278	403,320	296,327

RECEIVER SALES

(Source: RETMA)	Sept. '55	Aug. '55	Sept.'54
Television sets, units	978,838	586,577	986,136
Radio sets (except auto)	753,068	456,625	763,589

RECEIVING TUBE SALES

(Source: RETMA)	Sept. '55	Aug. '55	Sept.'54
Receiv. tubes, total units	47,588,000	45,238,000	40,966,063
Receiv. tubes, value	$34,596,000	$33,099,000	$28,953,592
Picture tubes, total units	1,202,430	1,048,534	1,149,791
Picture tubes, value	$22,867,851	$19,812,567	$23,892,469

SEMICONDUCTOR SALES

	Aug. '55	July '55	Aug. '54
Germanium diodes, units Silicon diodes, units	1,700,000	911,000	1,150,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	Latest Quarter	Previous Quarter	Year Ago
	2nd '55	1st '55	2nd '54
Vacuum (non-receiving)	$8,933,453	$8,784,478	$9,851,020
Gas or vapor	$3,365,008	$3,747,490	$3,987,036
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes	$13,193,395	$14,229,442	$16,429,553
Gaps and T/R boxes	$1,677,574	$1,434,683	$1,914,313

Quarterly Figures

TV SETS INSTALLED*

(Source: NBC Research Dept.)	Latest Month	Previous Month	Year Ago
	July '55	June '55	July '54
Total sets	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	Oct. '55	Sept. '55	Oct. '54
TV stations on air	473	473	431
TV stations CPs—not on air	110	108	147
TV stations—new requests	35	28	167
A-M stations on air	2,788	2,771	2,627
A-M stations CPs—not on air	110	113	126
A-M stations—new requests	235	219	137
F-M stations on air	539	538	558
F-M stations CPs—not on air	14	17	10
F-M stations—new requests	9	7	2

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Sept. '55	Aug. '55	Sept.'54
Aeronautical	44,183	45,203	40,695
Marine	52,908	52,440	47,360
Police, fire, etc.	19,153	18,877	16,109
Industrial	26,357	25,189	22,132
Land transportation	8,078	7,804	6,982
Amateur	139,628	138,852	121,762
Citizens radio	13,530	13,189	8,143
Disaster	319	319	305
Experimental	661	652	600
Common carrier	2,001	1,988	1,699

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Sept. '55	Aug. '55	Sept.'54
Prod. workers, comm. equip.	389,700-p	371,300-r	365,200
Av. wkly. earnings, comm.	$74.34 -p	$72.32 -r	$69.95
Av. wkly. earnings, radio	$70.30 -p	$69.43 -r	$68.57
Av. wkly. hours, comm.	41.3 -p	40.4 -r	40.2
Av. wkly. hours, radio	40.4 -p	39.9 -r	40.1

STOCK PRICE AVERAGES

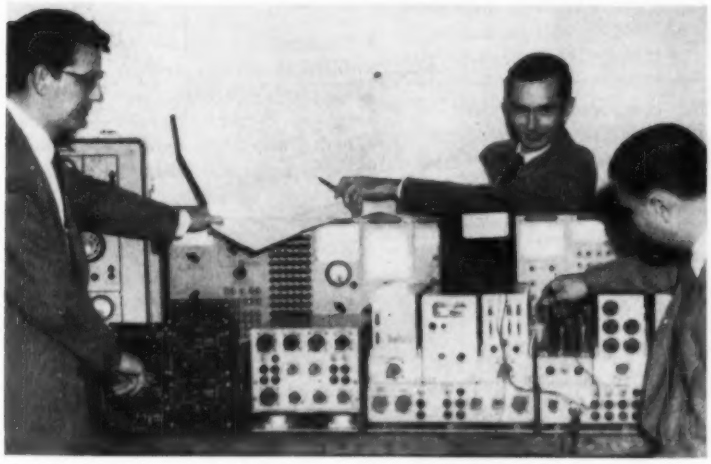
(Source: Standard and Poor's)	Oct. '55	Sept. '55	Oct. '54
Radio-tv & electronics	428.9	467.7	360.4
Radio broadcasters	486.9	537.7	400.7

p—provisional; r—revised
nr—not reported
*being revised in light of Census data

FIGURES OF THE YEAR

	TOTALS FOR FIRST NINE MONTHS 1955	1954	Percent Change	1954 Total
Television set production	5,760,506	4,733,315	+21.8	7,346,715
Radio set production	10,027,362	7,042,442	+42.4	10,400,530
Television set sales	5,149,997	4,645,063	+10.9	7,317,034
Radio set sales (except auto)	3,942,676	4,032,704	— 2.2	6,430,743
Receiving tube sales	347,668,000	266,050,907	+30.7	385,089,458
Cathode-ray tube sales	7,680,781	6,476,566	+18.6	9,913,504

U.S. Air Force Aerial Inspection Goes Robot



ELECTRONICS automatically controls photo settings and operation as . . .

Air Force uses computers to automatically adjust airborne cameras for best pictures

NEW automatic, electronic remote control system to operate aerial cameras in high-speed photo reconnaissance, developed by the Air Research and Development Command, is now used by the Air Force. The equipment, known as the Universal Camera Control System, (UCCS) can operate in flight without human attention. It eliminates the need for many camera controls and can be adapted to operate as many as 11 cameras.

► **How**—The heart of UCCS is a series of analog computers into which focal length, camera angles, film sensitivity, shutter, type of lens, ground speed and altitude information is set manually. After that, all operation is automatic and the system constantly adjusts the cameras for best pictures.

For night work, the system records when flash bombs have been released then calculates when each is to explode and works camera shutters accordingly. The equipment is built on a building block plan so that faulty electronic assemblies can be changed easily.

► **Who**—The Aerial Reconnaissance Lab at Wright ADC laid out the performance requirements and general electronic design of the system. The firms that developed and constructed the system are the Bill Jack Scientific Instrument Co., which did much of the development work, A. B. DuMont Labs, Chicago Aerial Industries and Fairchild Camera and Instrument Corporation.

► **Ike's Plan**—Practicality of aerial photographic inspection of military installations in both Russia and the U. S., as proposed by President Eisenhower, has been questioned by the U.S.S.R. But the value of the method has been upheld by both the U. S. government and private aerial survey firms.

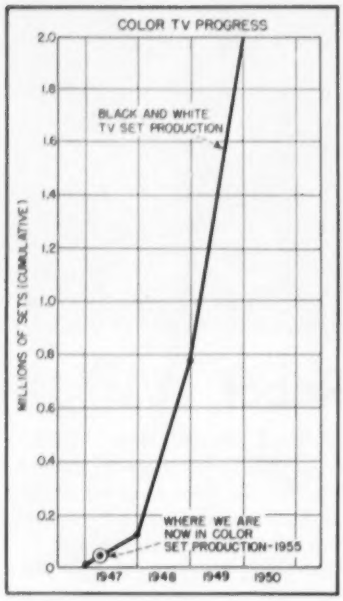
Photographic Survey Corp. of Canada has pointed out that even during World War II, aerial photos taken at 30,000 feet showed objects as small as 18 inches. Today, with the aid of electronics, a jet fighter ten miles above West Germany can photograph Czechoslovakia, Poland as far east as Warsaw, all of Hungary, as well as a large part of the western areas of Romania and the Ukraine.

Color TV Warms Up For Takeoff

Industry moves ahead in color planning and sales, but has a long way to climb

IN November, NBC, RCA and Westinghouse stepped-up their tv activities. The network announced a $12-million program to expand its color facilities in New York, Chicago and Hollywood, doubling its present live-color schedule of 40 hours monthly by the fall of 1956. It also announced that its station in Chicago, WNBQ, will be made an all-color tv station by April 15, 1956.

► **Tube**—Westinghouse announced



a $1-million program to buy equipment for the production of its new all-glass color tv picture tube which it feels will be ready for the market next spring.

▶**Sets**—RCA reports a current sales rate of 1,000 color sets a week. A recent survey by the firm showed its distributors' color-set sales in individual markets. Its Cincinnati distributor reported that 68 color sets were sold during the World Series. Its Washington, D. C. outlet reported sales of 28 sets to consumers and 7 to public places during the first three weeks of October.

The RCA Philadelphia distributor, during the three-week period before, during and after the Series, sold 333 sets to authorized dealers who moved 109 to consumers and public places. In the Los Angeles area, 181 color sets were sold in a 10-day period before and during the Series.

▶**Time**—Despite sizable gains being made in color-set production and sales, the industry has a long way to go to equal present black-and-white business. This is shown in the chart of present total color set output on black-and-white tv's time scale. On that basis, color tv now is about where monochrome was in mid-1947.

More Small Computers Appear

Prototype machine employs magnetic amplifiers. General purpose unit is desk size

MAGNETIC amplifiers have made their appearance in the electronic digital computer field. A business-type machine announced by Sperry Rand uses magnetic-amplifier units known as micro-feractors instead of electron tubes or transistors.

A prototype unit was built last June and models will be available early in 1957. It will sell for about $12,500.

Other computer designers, engaged largely in government work, are working on machines combining transistors and magnetic amplifiers. The transistors will provide the high-speed switching while the magnetic amplifiers will build up the necessary amplification for driving the ferrite-core memories.

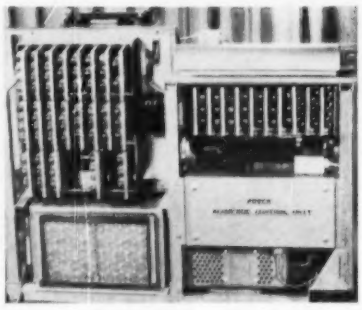
General Purpose—A desk-sized computer designed for engineering and scientific computation has been unveiled by Librascope of Glendale, Calif.

The machine has 16 basic orders. A library of subroutines is available. The magnetic-drum memory stores 4,096 30-bit words. The machine operates serially using single-address internal binary operation with fixed point.

Access time varies from 2 to 17 milliseconds. Clock frequency is 120 kc. Addition requires 0.26 milliseconds excluding access time; multiplication and division require 17 milliseconds. The machine consumes 1.5 kw; sells for $29,800.

▶**New Company**—Boston's Laboratory For Electronics, makers of character recognition devices and other electronic equipment, is working on a general-purpose digital computer.

Through arrangement with British Tabulating Machine, LFE intends to have available a comprehensive line of data-processing equipment, it is reported.



Librascope general-purpose computer

▶**Tandem**—In some government applications, any failure of data processing equipment could be disastrous. A new wrinkle is connecting two IBM model 704 computers in tandem with connecting equipment to enable one machine to act as a spare in the event of failure.

The model 704 is a large-scale digital computer especially designed for engineering and scientific computation.

Electronics Gains In Atomic Energy

Many companies move into the field as peacetime use of nucleonics gains ground

TWENTY percent of the exhibitors at the U. S. Nuclear Congress Exposition in Cleveland are in electronics. At the recent atomic exposition in Geneva in August and in New York in October nearly 40 percent of the exhibitors were electronics producers.

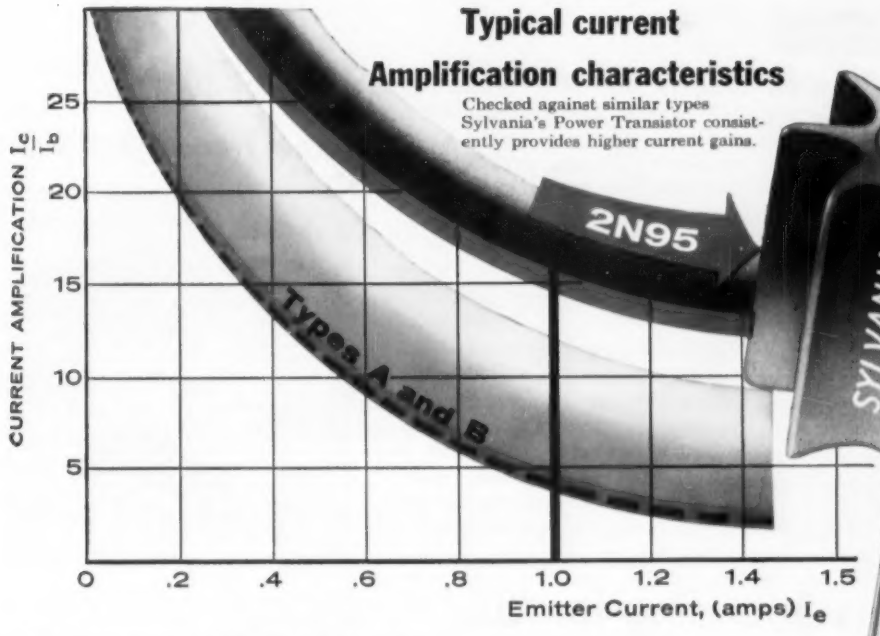
▶**Equipment**—For many electronics firms now in the atomic field, instrumentation is the big business. It includes prospecting equipment, radiation monitoring instruments, instrument components, low-level anticoincidence counters, radiation spectrometers, pulse-height analyzers, and medical instruments.

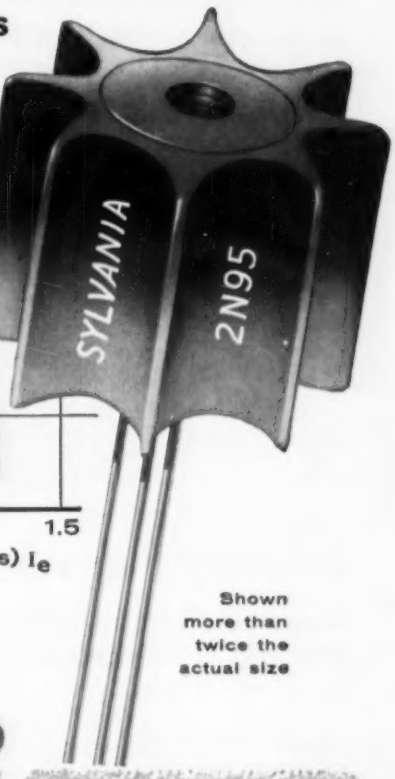
But electronics manufacturers

(Continued on page 10)

Typical current Amplification characteristics

Checked against similar types Sylvania's Power Transistor consistently provides higher current gains.





Shown more than twice the actual size

Sylvania NPN Power Transistor 2N95 Exhibits

3½ times more gain

Operated at 1.0 amp emitter-current, the Sylvania 2N95 Transistor typically provides a current gain of 17 . . . 3½ times that of comparable types A and B. Even at 1.5 amp emitter current the 2N95 typically exhibits a high gain of 13 . . . in fact, as the curve shows, the Sylvania 2N95 provides the highest gain over the widest range of operating current conditions.

In addition, Sylvania's 2N95 combines all the important features you want in a power transistor, whatever your application. If, for example, yours is a switching application, the 2N95 offers high gain at high currents.

Designed for low thermal resistance, the Sylvania 2N95 Transistor provides dissipation up to 2½ watts without an external heat sink and up to 4 or more watts with a suitable heat sink. This insures stable operation in high ambient temperatures.

You compare

Check the Sylvania 2N95 against similar Transistor types yourself—for current gain as well as all of these important power Transistor features.

Does the Sylvania 2N95 offer—	answer
1. lower cost	yes √
2. low input impedance	yes √
3. low thermal resistance	yes √
4. high current switching	yes √
5. high current gain	yes √
6. mounting for air cool or heat sink	yes √
7. hermetic seal	yes √

A smaller version for heat sink mounting, the Sylvania 2N102 is also available with the above features.

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are not only in instrumentation for the atomic field. Sylvania, for example, is producing reactor fuel elements. Others produce special electronic components for reactors. As much as $85,000 worth may be used in the typical small unit.

► **Potential**—It is estimated that a total annual volume of over $200 million in electronic equipment will result within the next ten years from the expansion of the peaceful use of atomic energy. In addition, there will continue to be considerable government and military business for the industry.

This volume will not be gained without increased expenditures for control and instrumentation research. According to the Atomic Industrial Forum, such spending will rise from the $106,000 of 1953 to $4.2 million by 1958.

It was pointed out that the industry does not know which type of reactor will prove superior in the near future. Consequently the development of control and sensing components will have to be approached on a piece by piece basis. For instrumentation components, however, design and development can proceed nearly unhampered because the general outline of the system is known.

Industry Plans Spending for '56

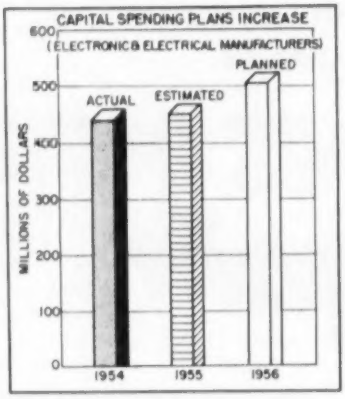
Companies schedule increased plant and equipment outlays, see increased sales

SPENDING for new plants and equipment next year by electronic and electrical machinery firms will be 13 percent higher than this year, according to a preliminary survey of business' plans for capital spending in 1956 by the McGraw-Hill Department of Economics.

Over $507 million will be spent by companies in the field in 1956 compared to $449 million this year and $439 million in 1954. Most of the firms surveyed believe that they will equal or exceed their 1956 spending in 1957. Some 62 percent of companies surveyed are planning about the same investment and 10 percent expect to increase plant and equipment investment in 1957.

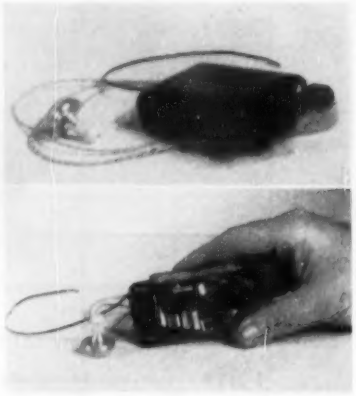
► **Sales Higher**—The survey also shows that electronic and electrical machinery firms expect sales in 1956 to be 7 percent higher than in 1955, explaining to some extent the reason for increased expansion. The sales increase equals that expected by industry as a whole. For individual industries the expected increases range from 2 to 12 percent.

► **Status**—Although spending in the electronics and electrical machinery industry will be up in 1956, plans are not yet equal to the peak expenditures made in 1953. Also, compared to all manufacturing the increase for the electronics industry is relatively small. Manufacturers as a whole plan to increase capital spending 30 percent in 1956. The largest increases are in primary metals, the chemical industry and the automobile industry.



► **Future**—Indications that plant expansion in the electronics and electrical machinery field will continue in 1957 show that the industry may not lose its expansion momentum. Although such plans are tentative now, in the past companies have usually added to their advance plans, as the target date drew near.

Wrist Radio Uses Three Transistors



Wrist radio, complete with earphone and a few inches of antenna

FULL advantage is taken of the inherent small size of the transistor in a wrist radio receiver just announced.

The receiver contains three transistors. One is employed as a regenerative detector and the other two comprise the audio stages. One control allows slug tuning from 550 to 1,600 kc and the other is a regeneration control.

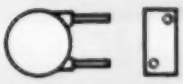
► **Operation**—Sensitivity of the receiver, designed by Linear Equipment Labs, Copiague, N. Y., is high. In the environs of New York City no antenna is needed for most stations. Six inches of wire is sufficient to pick up the weaker locals. At 30 miles from the city, one to three feet of antenna provides reception.

Mercury cells provide 6 volts to power the receiver. Total power input is 3 milliwatts.

Operation of the detector at the point of oscillation is different from that of vacuum tubes. No beat note is heard with the transistor detector of this receiver. Instead, circuit constants have been chosen so that oscillation takes place at a low pulse rate, similar to that of motorboating in an audio amplifier. The effect on the listener who misadjusts the regeneration control while tuning is much less disconcerting.

(Continued on page 12)

ceramic capacitors designed for mechanized assembly

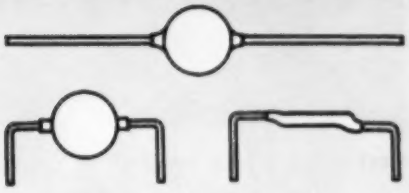


Pin Terminal Disc Ceramic Capacitors
The short, stiff terminals, 3/16" long, are accurately held to predetermined lead spacings. Closely controlled coating "pants" on the leads prevent resin from extending beyond the tangent line of the disc, yet no bare disc is exposed between leads. Available in bulk or in Tube-Paks.

NOW

Just as Sprague pioneered in the automatic *manufacture* of capacitors, it now takes the lead in supplying these capacitors for automatic *insertion*. New ceramic capacitor configuration—with double-tinned leads and terminals spaced precisely to a tolerance of ±.005"—assures foolproof automatic insertion in printed wiring boards. New packaging means top efficiency in handling, testing, and feeding the capacitors. And whichever styles you choose, you benefit from the advanced manufacturing techniques . . . exhaustive quality control procedures . . . and priceless on-the-spot engineering counsel which have built Sprague's reputation.

Brief descriptions of the designs and packages are shown at right. Complete information is available on letterhead request to the Technical Literature section, Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.



Diametral Lead Disc Ceramic Capacitors
After tape loading in magazines by the manufacturer, these capacitors need only have their leads precut before automatic insertion.

Taper-Tab Terminal Disc Ceramic Capacitors
Flat terminals are designed to jam easily into chassis slots, holding capacitors firmly during subsequent assembly steps prior to dip soldering. Available in bulk or in Tube-Paks.

Tube-Pak★ Packaging
Up to 200 disc capacitors, pin terminal or taper-tab terminal, can be packed in each two foot long Tube-Pak. These slotted cylindrical magazines are a perfect fit for automatic insertion equipment now in use by several leading television manufacturers. Both types are plugged at each end before shipment.

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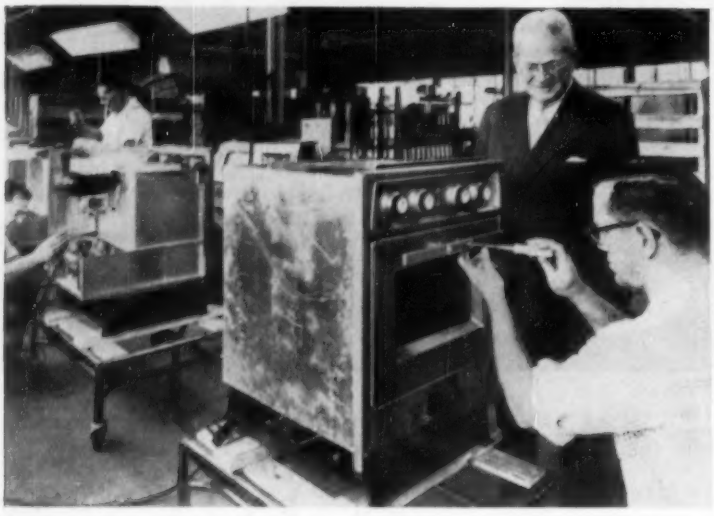


FIRST electronic range comes off the Tappan Stove production line as . . .

Home Cooking Goes Microwave

Units priced at $1,200 go on the consumer market. Plant expansion to boost output

MAGNETRONS started moving into home kitchens last month when the Tappan Stove Co. put a microwave range designed for home use on the market. The electronic unit was developed in conjunction with Raytheon which has had a commercial electronic range available for some time.

▶ **Features**—The range is offered by the firm as a built-in or stack-on type. It weighs 150 pounds and is about the same size as conventional built-in ovens. It incorporates an electric unit for browning, since microwave cooking cooks uniformly throughout and doesn't produce a hardened surface.

Temperature controls have been eliminated on the new range. The four controls are high and low speed selectors and individual timers for the microwave and browning units. The microwave timer is calibrated in seconds for the first three minutes of its settings because of the fast cooking speed. A potato can be baked in 5 minutes, a five-pound rolled rib roast in 30 minutes and a two-layer cake in six minutes.

The range operates on 220-volts with the same type of cable as an electric range. It requires no special installation or plumbing. The magnetron operates at 2,400 mc, a frequency assigned by FCC for microwave cooking. Power is supplied by a four-tube rectifier unit.

▶ **Market**—Although Tappan does not plan immediate nationwide distribution of the electronic range, it will be offered in Detroit and several other major markets this year. The introduction is being limited to enable factory service personnel and home economists adequately to train distributor personnel.

Although the price of the range is higher than conventional units, the cost of operation is lower, according to Tappan.

Tappan is allocating some of the space provided by a $300,000 plant expansion for increased electronic range production. GE plans to put its version of the electronic range on the market in 1956. Other major range makers including Westinghouse and Frigidaire are also expected to move into the field.

Small Business Gets More Air Force Work

Total of $20 million more in prime contracts went to firms with under 500 workers

AIR FORCE spending for electronic equipment totaled $350 million in fiscal '55. The Air Force spends more for electronics than any other armed service.

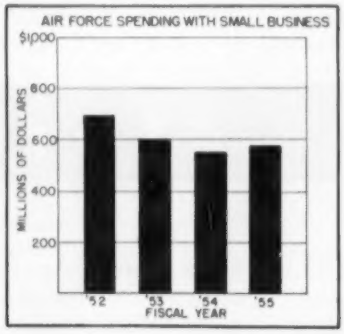
Small business firms, those having less than 500 employees, are getting more of this business. In fiscal 1955, small business was awarded $20 million more in prime contracts than in 1954. See chart.

Total awards were less than in 1953 and 1952 but an apparent downward trend has been reversed. The figures represent all Air Force awards to small business. A significant portion goes for electronics.

▶ **Orders**—During fiscal 1954, a total of 5,614 awards of over $10,000 were placed with small business for a total value of $425.2 million. In addition, $131.4 million was placed in orders under $10,000 to bring the grand total to $556.7 million. In fiscal 1955, 801,555 contracts and purchase orders were awarded worth a total of $576.8 million.

▶ **Reasons**—Air Force expenditures rose from $5.6 billion in 1954 to $6.1 billion for fiscal 1955. More of the equipment needed by Air Force in '55 could be produced by small business.

In 1954, it was estimated that



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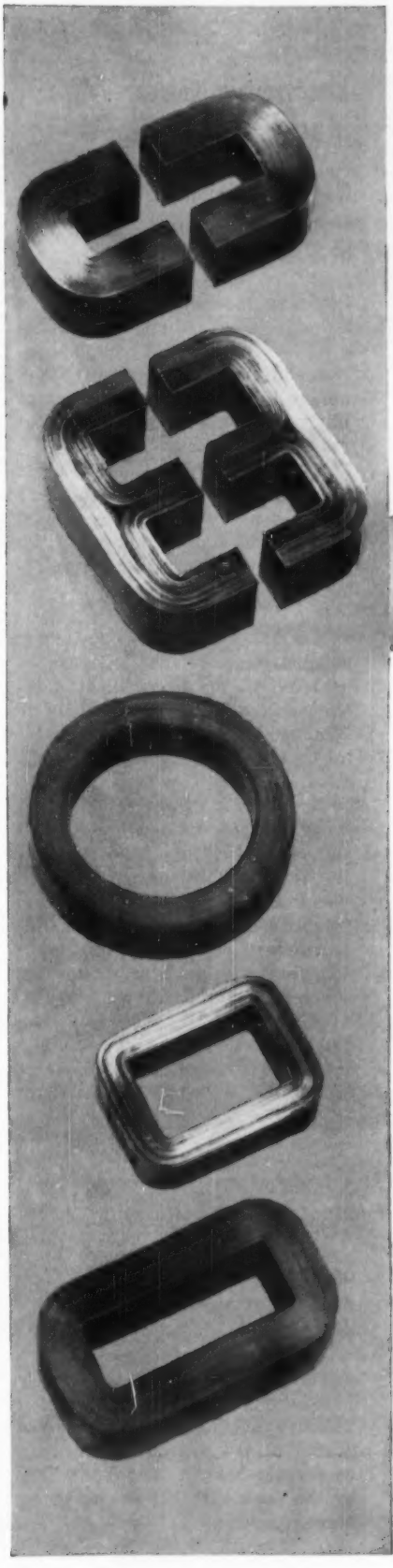

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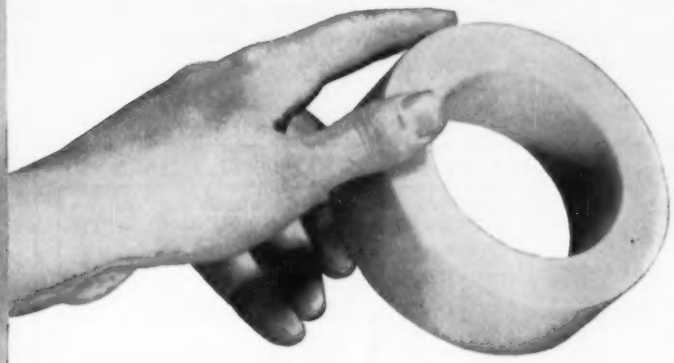

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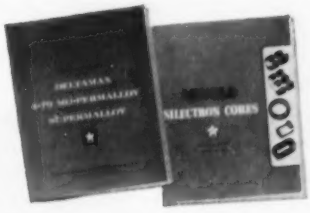
Our facilities for production and testing are highly modern and complete. Arnold is a fully integrated company, controlling every manufacturing step from the raw material to the finished core, and therefore best able to maintain high quality control. You'll have at your command the most complete line in the industry . . . containing every type, shape or size core you may require to meet design needs or electrical characteristics.

Many sizes of Arnold Tape-Wound Cores are carried in stock for immediate delivery. ● *Write for additional information*, and let us quote on your requirements and help solve your problems.



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Write for these Booklets

1 *BULLETIN TC-101A* . . . "Properties of Deltamax, 4-79 Mo-Permalloy and Super-malloy"—28 pages of technical data on Arnold Tape-Wound Cores of high-permeability alloys.

2 *BULLETIN SC-107* . . . "Arnold Silectron Cores"—round, square, rectangular, or C and E cores; 52 pages of data on shapes, sizes, properties, etc.

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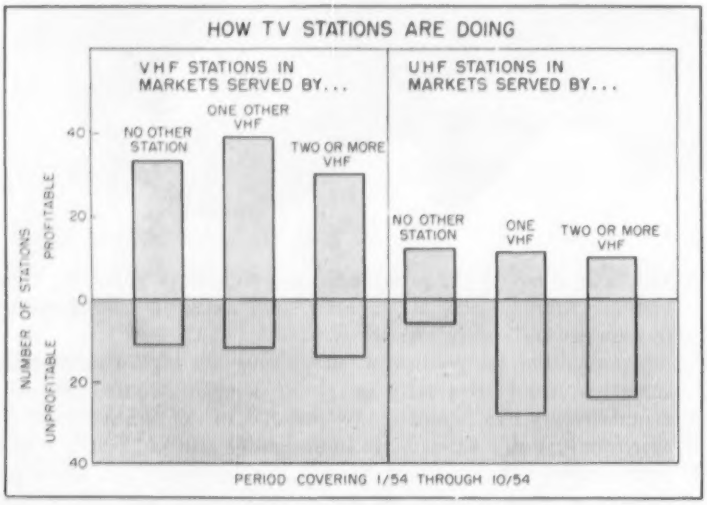
contracts worth $733 million could be handled by small business. For 1955 the figure was $755 million. When actual awards were made, 76 percent of the amounts in both years went to small business.

This was due to prices that were out of line, physical facilities that were inadequate, inability to meet delivery dates or no bids being received from small business.

▶ **More**—Along with the increased volume of Air Force prime contracts, small electronic businesses are receiving greater help in securing subcontracts. Large prime contractors have been active in supporting small businesses.

GE, for example, has a manufacturing services division to funnel orders to defense subcontractors and suppliers that have available production capacity. The government has asked large prime contractors to report periodically on the number of subcontracts awarded to small business.



FCC Looks At TV Competition

Survey of uhf and vhf stations shows effect of competition, population and programs

THIRD survey of post-freeze tv stations by FCC compared the profits of uhf and vhf stations. As shown in the chart, the number of unprofitable vhf stations increased with the number of vhf competitors. For uhf stations with vhf competition, the same thing happened only more so.

▶ **Losses**—In areas served by two or more vhf stations, 70 percent of surveyed uhf stations and 32 percent of the vhf stations covered had continuing monthly losses during the ten-month period of the survey. In areas served by one vhf, 71 percent of the uhf's and 29 percent of the vhf's were unprofitable every month. In single-station markets, 33 percent of the uhf's and 25 percent of the vhf's were in the red.

▶ **Other Factors**—In addition to competition, the size of the market and programs offered were important to the profit-loss picture. Over half of the vhf stations with continuing monthly losses were in communities with less than 75,000 population. As for the effect of network programs, the study showed that only 18 percent of the vhf stations that carried network programs in excess of 7.5 hours a week and 38 percent of uhf lost.

Electronic Gear Withstands Atom Blast

Communication equipment stands up under impact of 30-35 kiloton blast

DETAILED information released on the effects of atomic-blast exposure on commercial communication equipment indicates that it is generally much more resistant to nuclear effects than some typical residential structures.

A brick building located at a test point 4,700 feet from ground zero collapsed but a tv receiver, located in the same building, was still in operation without any servicing required.

▶ **Damage**—Mobile-radio antennas members were bent but still usable as a result of direct blast damage at the building location. Minor damage to coaxial cable coverings was caused by thermal radiation.

The plastic cases and knobs on tv sets and radios were cracked and chipped when struck by falling objects. However, performance was in no case seriously impaired.

Under blast conditions, whip antennas on mobile rigs showed a tendency to bend or break off where attached to the vehicle. Television receiving antennas were damaged beyond repair.

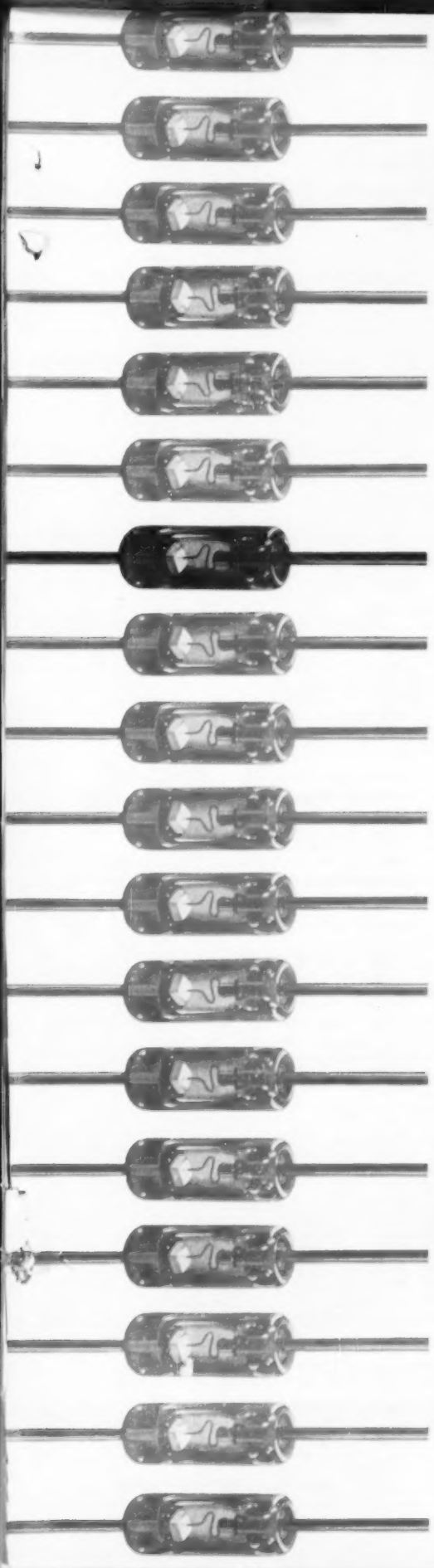
Outage of one a-m broadcast transmitter was due to the failure of the 60-cycle power supply.

Operations Research Gains In Industry

Some firms establish new departments; others retain consultants

APPLICATION of operations research is gaining ground in the electronics industry according to a survey reported at the operations research conference held in New York City by the Society for Advancement of Management.

(Continued on page 16)



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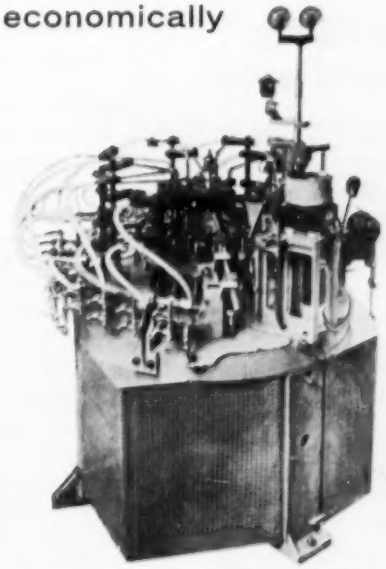

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Designers and builders of special automatic and semi-automatic equipment for all industrial operations.

▶**Survey**—Of 33 electrical and electronic firms queried, 22 replied. Twelve of the 22 companies now use operations research and have a total of 59 people assigned to the work. Six of the companies use consultants for operations research studies.

▶**Use**—Operations research was developed during World War II by the military. According to SAM, it helps executives predict the results of an operation under different sets of variable conditions. This provides a sound basis for decision-making and forecasting.

Operations research has been applied to marketing, determining radar reliability, blending raw materials, scheduling of personnel, industrial communications, budgeting, financial incentives, transportation, traffic, allocation of sales effort and production and inventory control. Operations research has boosted use of electronic computers in business and industry.

Personal Paging Business Advances

Potential market seen for thousands of tiny vhf receivers and 200 transmitters

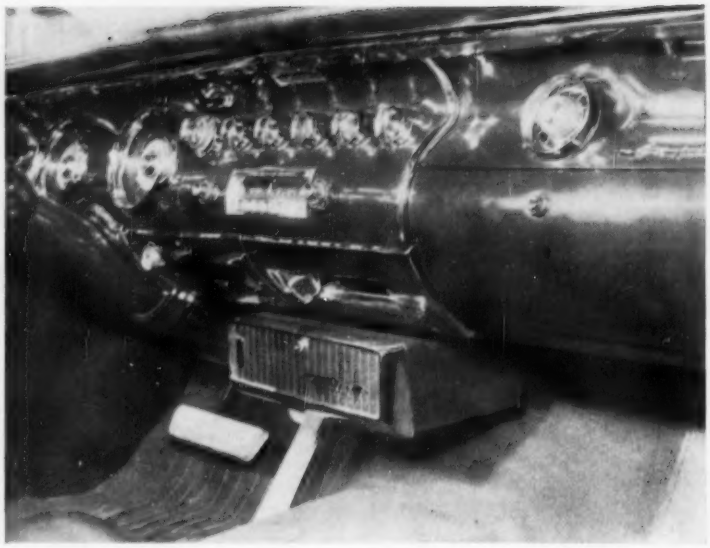
PHYSICIANS, delivery services and repair crews are finding radio paging essential in their work.

The paging transmitter continuously broadcasts numbers assigned to the individuals paged until the person calls into the office by telephone.

Signals are received on a pocket-size vhf receiver. Transmitters operate on 35.58 or 43.58 mc and cost about $2,000. The paging service usually operates on a subscription service with each subscriber paying $12 to $15 a month.

▶**Operators**—A paging service is in general an outgrowth of telephone answering services. There are currently 50 to 100 services with an estimated total of 4,000 receivers.

Potential market at present is about 200 transmitters.



RECORDS can now be heard while traveling as . . .

High-Fidelity Hits the Road

Automobile record players introduce new style and disk standards and open new market

FOR $80, any owner of a 1956 Chrysler Corp. automobile may have his car equipped with a newly developed record player that mounts under the car's dashboard. The player's pickup arm will track the record under all road-operating conditions . . . short of a collision.

Each player is supplied with six records. Additional records can be purchased for $2.50 to $4.95.

▶**Technical Details**—The record player was developed by CBS-Columbia Laboratories. It operates at 16⅔ rpm from 18 v 60 cps, which is converted from 12 v d-c cps by a vibrator power supply.

The pickup cartridge is of ceramic and is mounted in a counterbalanced arm that concentrates the mass at the pivot point. The cartridge is fed into the car's radio.

Records are 7 inches in diameter and are cut with 550 to 700 groves per inch depending on whether music or speech is recorded. (LP records have an average groove pitch of 235 lines per inch.) Playing time of the records varies from 20 to 40 minutes per side depending on the groove pitch.

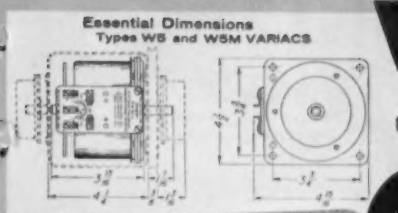
The fine grooves of the 7-in. record require a stylus with a 0.3-mil tip radius, ten times smaller than that used with conventional 78-rpm records.

▶**Other developments**—A German portable, distributed by Chemtron Industries, Inc., N. Y. features a-m/f-m reception and a built-in 45-rpm record player. The unit operates from 110/220 v a-c or from self-enclosed batteries. The rec-

A-M/F-M radio has built-in 45-rpm record player

(Continued on page 20)

ANNOUNCING NEW W5 Variacs®



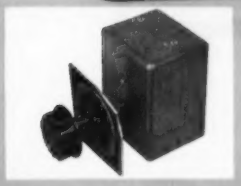
- ★ Higher Rating
- ★ More Rugged Construction
- ★ U-L Approved
- ★ Industrial-Type Cased Models — *Completely Enclosed*
- ★ Portable Model — *with Overload Protection*

Basic Type W5 VARIAC
. . . 6 amperes rated and 7.8 amperes maximum current (0.90 kva)

Type W5MT3 VARIAC
. . 6 amperes maximum . . . 5 amperes rated current . . . light weight, provided with carrying handle, overload protection, line switch, convenience outlet, 3-wire grounding cord and plug (W5MT is identical except 2-wire line cord is used)

The new W5 Series VARIACS are another step in General Radio's continuing research and development program to assure users that the VARIAC will always be the best continuously-adjustable auto-transformer available anywhere in the world.

The new W5's have many improvements over the popular Type V-5, electrically and mechanically and in operating convenience.



Type W5M VARIAC, panel mounted . . . four screws in corners of square base

Klixon-type manually reset thermal overload breaker provides protection from prolonged overloads

Type W5M VARIAC . . . 6.5 amps maximum . . . 5.0 amps rated current . . . completely enclosed . . . for wall, bench, panel or behind-panel mounting . . . aluminum gray Hammertone finished cases with four conduit knockouts

Some Features Are:

Basic W5 model has 20% Increased Power Rating

Drawn Wrought-Aluminum Square Base, Designed for Excellent Heat Transfer . . . much more rugged . . . will withstand MIL-T-945A Shock and Vibration Tests

Improved Brush Radiator . . . setting of radiator and brush independent of position of shaft . . . disc-type radiator completely covers and protects Duratrak brush track

Enclosed single and ganged models in industrial-type rectangular cases . . . can be panel, behind panel, wall or table mounted . . . conduit knockouts conveniently located . . . all mounting hardware included

Same mounting holes as all V-5's plus additional mounting holes in each corner of square base for convenience and extra rigidity. In most cases can be substituted directly for V-5's.

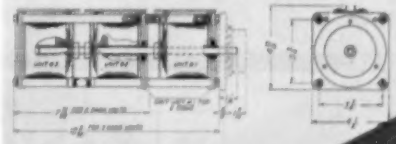
INPUT Volts	KVA	OUTPUT Volts	Amperes Rated	Amperes Max.	Type	Price	Description
115	0.90	0-115 0-135	6.0 6.0	7.8 6.0	W5	$17.00	*Uncased*
115	0.75	0-115 0-135	5.0 5.0	6.5 5.0	W5M	21.50	*see footnote A*
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT	26.50	*see footnote B*
115	0.69	0-115 0-135	5.0 5.0	6.0 5.0	W5MT3	28.50	*see footnote C*
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5H	19.00	*Uncased*
230*	0.60	0-230 0-270	2.0 2.0	2.6 2.0	W5HM	23.50	*see footnote A*
230*	0.55	0-230 0-270	2.0 2.0	2.4 2.0	W5HMT	28.50	*see footnote B*

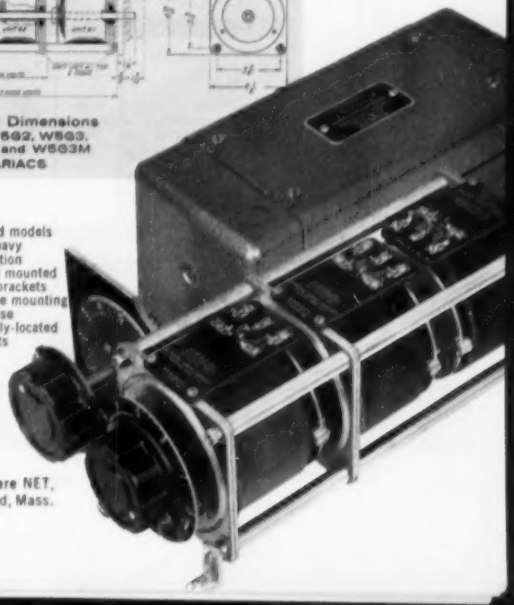
*The 230-volt models can be used on 115-volt lines. When so used, the 0-270 volt output range is limited to a rated and a maximum current of 1 ampere.

A Completely enclosed with conduit knockouts
B Bench model with 2-wire line cord, line switch, outlet, overload breaker and carrying handle
C same as (B) except 3-wire grounding line cord and 3-terminal plug

Type W-5 VARIAC Assemblies

Type	Description	Price
W5G2	*2-Gang W5*	$41.00
W5G2M	*2-Gang W5 completely enclosed with conduit knockouts*	49.00
W5G3	*3-Gang W5*	61.00
W5G3M	*3-Gang W5 completely enclosed with conduit knockouts*	69.00
W5HG2	*2-Gang W5H*	45.00
W5HG2M	*2-Gang W5H completely enclosed with conduit knockouts*	53.00
W5HG3	*3-Gang W5H*	67.00
W5HG3M	*3-Gang W5H completely enclosed with conduit knockouts*	75.00





Three-gang cased models showing extra-heavy internal construction . . . can be panel mounted . . . 4 mounting brackets provided for table mounting or vertical wall use . . . 8 conveniently-located conduit knockouts

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Raytheon's new Semiconductor Division Plant at Newton, Mass.

With this $3,000,000 plant Raytheon now utilizes approximately 180,000 square feet of space for semiconductor research, engineering and manufacturing activities.

Not only in better supply, but of the highest quality, uniformity and reliability. *All are PNP Germanium Transistors hermetically sealed.*

actual size.

SUBMINIATURE LOW FREQUENCY TRANSISTORS

Type	Collector Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
2N130	−6	2.0	6	−1.0	350	22	25	0.6
2N131	−6	2.0	6	−1.0	700	45	22	0.8
2N132	−6	2.0	6	−1.0	1500	90	20	1.2
2N133	−1.5	1.0	6	−0.5	700	45	10	0.8
new **2N138**	−6	2.0	6	−1.0	1800	140	25	1.2

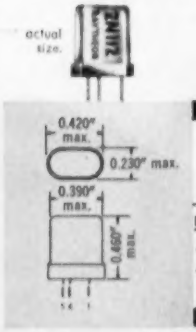
RAYTHEON TRANSISTOR FIRSTS

FIRST company to make point contact transistors commercially available — in late 1948.

FIRST to mass produce germanium junction transistors — in late 1952.

FIRST to mass produce fusion-alloy RF transistors — in late 1954.

actual size.



HIGH FREQUENCY TRANSISTORS

Type	Collector Volts	Collector Cutoff μA	Emitter Current mA	Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Coll. Capac. μμf	Gain at 455kc db	Gain at 2 mc db	Rise time* μsecs	Decay time* μsecs
new **2N111/CK759**	−6	1	−1.0	50	25	3	12	33	18	—	—
2N112/CK760	−6	1	−1.0	55	40	5	12	35	20	0.05	0.06
2N113/CK761	−6	1	−1.0	60	65	10	12	36	22	0.04	0.05
2N114/CK762	−6	1	−1.0	75	100	20	12	36	25	0.02	0.03

*measured in circuit which will be supplied on request

Note: above characteristics are average except where noted

RAYTHEON TRANSISTORS

more in use than all other makes combined

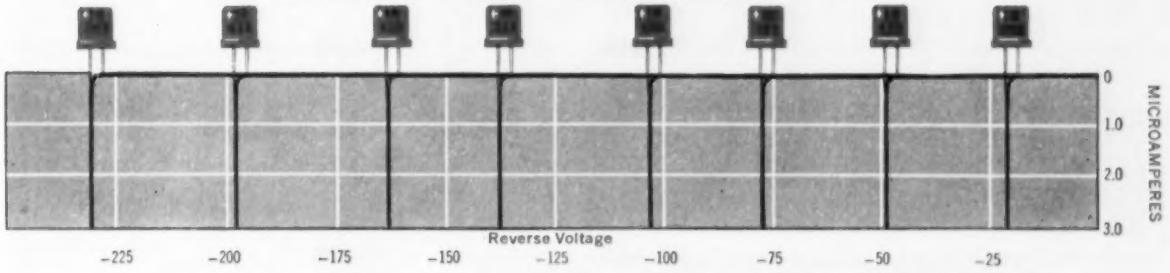
Want more information? Use post card on last page.

RAYTHEON *Presents . . .*

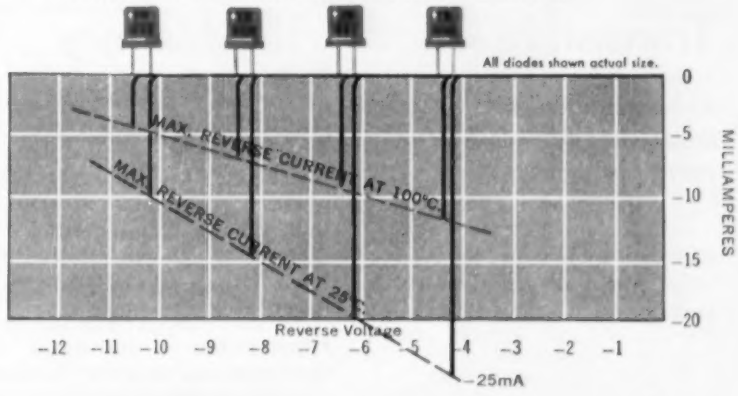
A COMPLETE LINE OF

Bonded Silicon Diodes

TYPICAL REVERSE VOLTAGE CHARACTERISTICS AT 25°C.



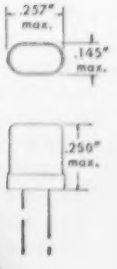
TYPICAL REFERENCE DIODE CHARACTERISTICS



Raytheon Bonded Silicon Diodes provide low reverse current and good stability at high temperature. Every diode receives four temperature cycles of one hour at −55°C and one hour at +150° C, followed by thirty-six hours at 95% relative humidity and 70°C. Exact characteristics are maintained after temperature cycling and stability remains excellent over long periods.

Type	Peak Inv. Volts	Min. Forward mA at +1.0V	Max. Reverse μA at Volts
1N300	15	8	0.001 −10
1N432	40	10	0.005 −10
1N301	70	5	0.05 −50
1N460	90	5	0.1 −75
1N303	125	3	0.1 −100
1N433	145	3	0.1 −125
1N434	180	2	0.1 −150
1N302	225	1	0.2 −200

Above ratings at 25°C



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Want more information? Use post card on last page.

ord player operates from the batteries too. European-type tubes are used.

Battery or a-c line operation is also a feature of a new RCA Victor portable radio and 45-rpm record-player combination now on the market.

SMALLER lighter equipment, like this airborne digital computer, is developed as . . .

Transistors Gain In The Military

Airborne digital computer and underwater torpedo control operate without tubes

ELECTRON tubes have been replaced by transistors in an Air Force airborne digital computer and in a Navy ultrasonic torpedo control system.

► **Airborne**—The computer, developed and flight tested by North American Aviation for the Air Force, uses some 1,000 transistors and etched circuits. It takes up only three cubic feet of space and weighs 125 pounds.

An electron-tube computer with half the capacity would be four times heavier and would take the space of an average closet. The computer uses less than 100 watts compared to about 3,000 watts for an electron-tube counterpart with only half the capacity.

The etched and transistorized circuits in the unit are designed in the form of 51 standardized panels for reliability and quick servicing. The panels can be pulled out like file cards for testing and replacement. The computer can continuously integrate 93 quantities simultaneously and generate continuous solutions of differential and trigonometric problems.

► **Underwater** — Developed by Westinghouse research laboratories for the Navy's Bureau of Ordnance, the new ultrasonic torpedo control is fully transistorized. The transistors can operate directly on the low voltage of the torpedo battery. This eliminates the need for a separate source of power and makes the system more simple and compact. The total power required for the control using transistors is only about one-tenth that of an equivalent electron-tube control. With transistors the warmup time of 30 seconds or more needed for electron tubes is eliminated. The transistorized torpedo is ready for instant operation.

Why Television Sets Are Failing Today

Tubes and capacitors lead as troublemakers; average is down to 1½ service calls

WITH the average number of service calls per tv set settling down to around 1½ per year, as compared to 6 or more in the early postwar days, the causes of trouble change also.

Percentage figures compiled five years ago (Why Television Receivers Fail in Service, ELECTRONICS, p 66, July 1950) are summarized in the accompanying tabulation for comparison with the 1955 year-end picture for representative service organizations.

Reason for Service Call	1955	1950
Replace regular tube	60	28
Replace picture tube	2	6
Repair antenna system	2	14
False call	1	13
Replace paper capacitor	9	4
Replace electrolytic	3	1
Replace selenium rectifier	2	—
Replace resistor	6	6
Repair or replace tuner	3	8
Replace other component	6	6
Repair regular connection	3	4
Repair etched wiring	1	—
Realignment and adjustment	2	12
Total	100%	100%

► **Trends**—Although tube performance in tv sets is much better today, the tube percentage figure is up for two reasons: the tube failure rate is still highest for the first few months, hence tube troubles run high in factory service organizations where many repair jobs are within the 90-day warranty period; and independent servicemen tend to replace weak tubes hoping the resulting higher gain will offset the circuit defect and avoid pulling the entire chassis. Where organizations train servicemen to repair only the primary cause of trouble, the tube percentage drops to approximately 35 percent.

With the almost complete demise of the service contract, false calls have just about vanished. However, with around 60 percent of its calls still made under service contracts, RCA Service Co. reports 4 percent false calls.

Although millions of antennas are now well over five years old,

(Continued on page 22)

JACK & HEINTZ
MODEL 50127-000
CONTROL PANEL

PHOTOS COURTESY OF
CONVAIR AND JACK & HEINTZ.

Miniature All-Angl
Barry Mount

ALL-ANGL Barry Mounts give sure protection

Jack & Heintz proved this in testing mounts to protect their Hi-Phase voltage regulators and control panels for Convair's supersonic F-102A interceptor.

No other miniature isolator tested could meet Procedure I of MIL-E-5272A. ALL-ANGL Barry mounts exceeded life-test requirements.

And the ALL-ANGL works in any position— to give sure protection for vital controls through every twist, turn, and dive in the aircraft's most violent maneuvers.

Write for Data Sheet J-11. And for your airborne requirements to meet standard MIL specifications, ask about All-Metl, Air-damped, and special Barry mounts.

Here's the mount that meets the new needs of today's jet aircraft and missiles — where equipment must have greater protection against shock and high-frequency vibrations — and where MIL-standard mounts prove inadequate.

BARRY CONTROLS incorporated **707 Pleasant St. Watertown 72, Mass.**

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

increased sensitivity of new sets may be one factor covering up gradual deterioration in antenna and transmission-line insulation.

One independent serviceman summarized his experience this year in one sentence: "Half the troubles are tubes and the other half are in the horizontal sync system."

Tube Machine Makers Stack Up Big Year

New plant expansions for increased tube output has upped machinery sales

GROWING production of all types of tubes has increased the business of the industry's tube machinery makers. One firm estimates that sales in the field this year will top $20 million.

► **Why**—A look at the plant expansions of the industry's tube makers so far this year indicates the reason for increased business. In the first 10 months of the year a dozen tube firms have announced new plant construction.

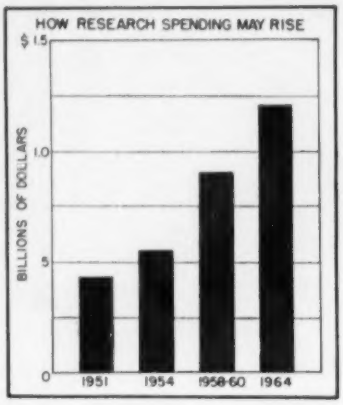
In the past month, two tube makers announced extensive expansions. Sylvania will construct a 110,000 sq ft receiving tube plant and Westinghouse has placed orders for $500,000 worth of new equipment, primarily exhaust machines, for color picture tubes.

► **Types**—Most of the production equipment sold so far this year has been for picture tubes and special-purpose tubes. The machinery market for standard receiving tubes has dropped in importance and consists mainly of replacement business.

► **Firms**—There are some 15 manufacturers of tube machinery. Among the largest producers are several tube manufacturers themselves. They build machinery for their tube licensees and for themselves. But most of the companies are independent machinery firms, some specializing solely in equipment for the electronics industry.

Research Heads For Billion Mark

Investment in research and development will rise as the industry's volume climbs



SPENDING for electronics research and development will reach a billion dollars a year in the next decade if present spending and sales rates continue.

Currently, the industry spends approximately 6 percent of its total sales on research and development. This figure is indicated by an analysis of the expenditures of 13 firms in the field and by a government survey of research in electronics and electrical machinery firms.

► **Companies**—Present importance of research in the industry has been indicated by recent statements of firms in the field. It was also pointed up at the American Management Association's special conference on managing product research and development.

RCA recently estimated that 80 percent of its business in 1955 will be in products and services introduced on the market during the last ten years.

IBM has indicated that it now spends about 4 percent of its gross on research and development. In its accounting and data processing division there are about 2,100 people working on development.

GE indicates that its Electronics Division's laboratory has a budget of $3.6 million. The laboratory has the following subdivisions: engineering analysis, semiconductors and solid state, thermionics, dielectrics and magnetics, advanced circuits, communication and computers, video circuits and display, microwave and radar, application engineering.

Remington Rand had a total of 75 people working on Univac five years ago. It now has approximately 500 in the division's engineering research and development group alone.

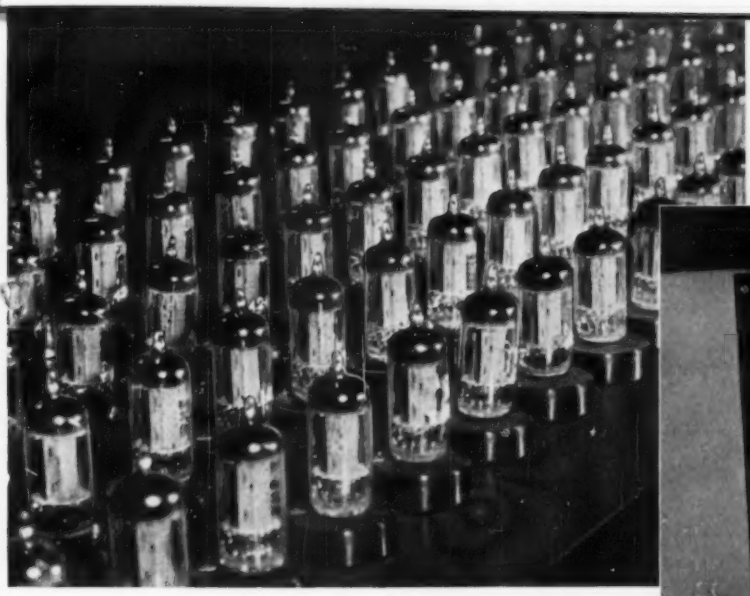
► **Budget**—Consolidated Engineering increased research and development expense from $165,502 in 1946 to $1.7 million in 1954, according to AMA. In the same period, sales increased from $925,787 to $15.7 million. The firm allocated research and development expense as follows: 21.5 percent for improvement of released products; 24.7 for product design; 35.9 for product development; 13.2 for applied research and 4.7 for studies and service. Its research and development expenditures are normally set at 10 to 12 percent of predicted sales for the next year.

Varian Associates has announced that it plans to up its research expenditures and plans to spend $500,000 on new product research this year.

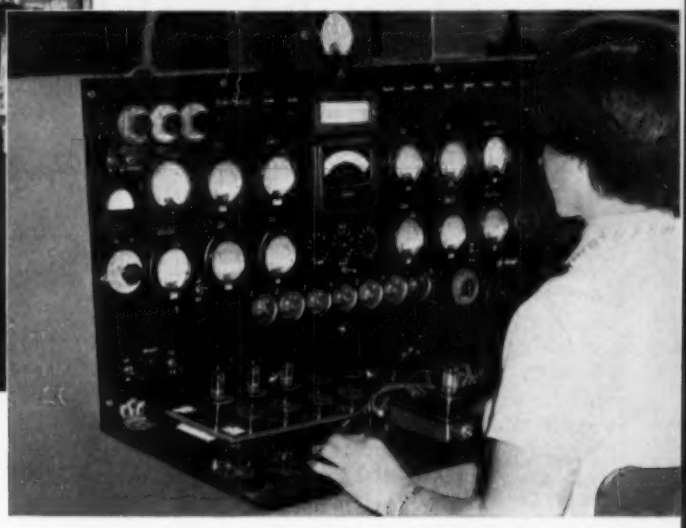
► **Shortages**—Growth of research in electronics is also indicated by the shortage of research personnel. A survey by the Department of Labor showed that in the electronics and electrical equipment industry, three-fifths of the surveyed companies reported shortages of scientists and engineers.

All the firms with shortages said that this was impeding their research and development programs. Several manufacturers of electronic equipment stressed that their shortage of research engineers and scientists was extremely acute. One of the companies had been able to fill only half the budgeted research positions.

(Continued on page 24)



LEFT: G-E computer tubes undergo a cut-off life test. The tubes are operated for long intervals with their grids biased to cut-off. Periodically the tubes are given a cathode interface check, to make sure no "sleeping sickness", or failure to respond to changed grid voltage, has developed during inactivity.



RIGHT: extensive instrumentation is used to test tube electrical qualities that closely affect operation in computer circuits. Zero-bias plate current; cut-off performance; any difference in cut-off between twin-triode sections—these are three of many characteristics checked.

G-E Computer Tubes are specially tested for qualities that safeguard computer reliability!

General Electric pioneered special tubes for computers . . . also developed tests such as those above, which assure that G-E tubes in your computer circuit can be relied on to meet designers' aims in all respects.

The tests are specific in purpose. Each covers one or more tube characteristics important in computer use, and which closely influence the accuracy and reliability of the equipment.

There is no substitute for G-E computer-tube quality, which starts with special tube design—extends through precision manufacture—concludes with exhaustive tube tests that relate directly to computer service.

Also . . . there is no counterpart to G.E.'s range of special computer tubes *now in production.* You have a choice of proved G-E types available for your present circuit needs, with new tubes constantly being added.

Ask for "G-E Computer Tubes And Their Applications" (ETD-1140). 54 pages—just off the press. A book every designer and builder will find useful! *Tube Department, General Electric Company, Schenectady 5, New York.*

* * *

● G-E computer-tube development is a continuing process, with new types being added regularly for faster, more advanced equipment, or to meet special customer requirements where volume warrants. Five types—proved popular—already are in full production:

GL-5844 **GL-6211**
GL-5965
GL-5915A **GL-6463**

Progress Is Our Most Important Product

GENERAL ELECTRIC

Subminiature Relay Makers Grow

More relay makers widen lines to include the small units for military use

IN the past two years, the number of relay manufacturers in the subminiature field has more than doubled. Today there are about 35 relay manufacturers who produce subminiature relays while in 1953 about 15 firms were in the field.

Main reason for the trend to miniaturization in relays, as with many other components, is that weight and size considerations are becoming increasingly more important in military equipment, particularly airborne gear, the principal market for the units.

▶**Market Survey**—One of the latest entrants into the subminiature and miniature relay field is Elgin National Watch Co. which has acquired two relay firms. In making its move into the field, it surveyed the market.

Elgin estimates 85 percent of the miniature and subminiature-relay business is accounted for by the military and aviation markets; 10 percent by the industrial market and 5 percent by the commercial equipment market.

Because of the trend toward greater use of business machinery and toward automatic production in industry, use of small relays in industrial and commercial lines is expected to increase considerably in the next 5 to 10 years. It estimates the military and aviation market will account for 50 percent of small relay output; the industrial field, 35 percent and the commercial field, 15 percent.

▶**Size Defined**—In differentiating between miniature and subminiature relays, Elgin defines the miniatures as those that have a volume of approximately 1 to 3 cubic inches and subminiatures as those with a volume of less than 1 cubic inch.

Electronics Grows In Business

Intercoms and dictating machines take the spotlight at Business Show

GROWING use of electronic equipment in the nation's business offices was mirrored at the National Business Show in New York City. Over 25 companies displayed electronic gear ranging from dictating machines to facsimile equipment. Electronic computers were not shown this year.

▶**Dictation**—Trend toward greater use of multiple dictating systems was evident. Up to 20 phones can be connected to a single recording unit. One manufacturer estimates that it is adding more than 1,000 new users a month. The price of the equipment is roughly ⅓ the price of individual dictating instruments.

Indications are that the systems can cut dictation costs by nearly 50 percent. A net saving of almost $15,000 was made by one user with 20 stations and 4 recorders. Annual savings of over $24,900 are expected when the system is expanded.

▶**Intercoms**—Estimates based on Department of Commerce figures place the annual value of intercommunication equipment shipments in the range of $20 to $30 million, more than double 1947 shipments of $9.9 million. A substantial part of this volume is accounted for by the office equipment field.

▶**Future**—Intercom and dictating machine firms see expanding sales ahead for the equipment. They feel that the vast market of over 4.1 million business establishments in the U. S., not counting individual offices, has hardly been scratched.

As for future equipment design changes, indications are that more dictation and intercom equipment may be combined in a single unit. A few companies already have such dual phone-dictation and intercommunications systems available.

Television Girds For New Markets

Vidicon tube prices are lowered. Low-priced tv station is demonstrated

SALES help for expanding television applications was indicated recently when RCA announced lower prices on two vidicon tubes and Dage demonstrated a complete tv broadcasting station costing less than $50,000.

▶**Tubes Drop**—Suggested resale prices were reduced from $315 to $230 on vidicon type 6198 which is used for industrial television applications. Type 6326, used in black-and-white and in color tv broadcast film cameras, was reduced from $565 to $515. According to RCA, the reductions were made possible by substantial savings in manufacturing costs.

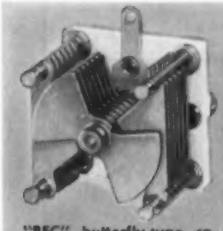
▶**Low Power**—The Dage station is designed for communities of less than 50,000 population. It is adapted from one developed by the firm for military installations overseas where stations now in operation include those in the Azores; Deflavik, Iceland; Thule, Greenland; and Bermuda.

The equipment meets the requirements of the recent FCC change in tv rules reducing the minimum required power of tv stations in small communities to 100 watts and eliminating any requirements as to antenna height.

▶**School Circuit**—Dage also demonstrated a plan to transmit audio-visual programs to schools via closed-circuit tv based on the use of a central point to originate all audio-visual activities. A three-

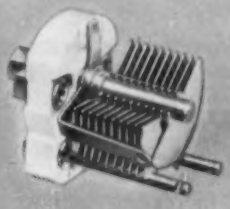
(Continued on page 26)

for VARIABLE CAPACITORS...



"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.

"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".

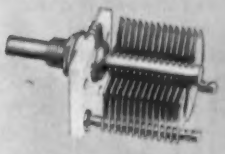


"APC" A compact, high quality air dielectric trimmer. Extremely high resistance to temperature changes, moisture and vibration.

"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

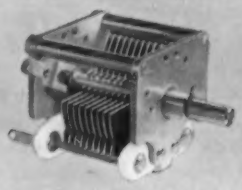
"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

naturally,

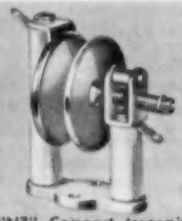


"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.

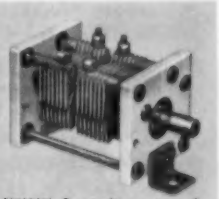
"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.



"RMC" Similar to "MC-S" but featuring extra rigid design. Heavy frame of aluminum tie rods and end plates.



"NZ" Compact transmitting neutralizing capacitor designed for easy and accurate adjustment. Long leakage paths to ground from both rotor and stator.



"VU" Permits use of "lumped constant" circuits up to 500 MC. Two sections in series eliminate rotor wiper. Pyrex glass ball bearings eliminate noise from usual metal-to-metal bearings.

it's HAMMARLUND

For commercial, military and industrial applications, you just can't beat Hammarlund Variable Capacitors for uniformly high quality design, materials and workmanship. The capacitors illustrated here are just a small representative portion of the complete Hammiarlund line. In addition to stock designs, Hammarlund offers you unparalleled variable capacitor know-how in development, design and production. Whatever your needs, when it comes to special or standard variable capacitors, naturally, come to Hammarlund.

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HAMMARLUND MANUFACTURING COMPANY, INC.
460 West 34th Street, New York 1, N. Y.

vidicon color tv film camera which uses a folded optical system was also demonstrated by the firm along with a tv-microscope system and a servo pan and tilt mechanism for remote control of industrial tv.

Civil Defense Fosters Electronics Sales

Federal, state and local governments spend increasing amounts on equipment

IN fiscal 1955, approximately $2.4 million was available from the federal government for civil-defense communications equipment. When matched by state and local groups, this brings the total available near the $5 million mark.

To qualify for federal aid electronic equipment to be purchased by local units must meet engineering specifications of the Federal Civil Defense Administration.

► **Markets**—A number of electronics manufacturers have garnered a sizable share of the business. Probably the largest amount has been spent with two-way mobile radio manufacturers. But other equipment is taking a share.

For example, the Cincinnati division of Bendix Aviation, received an order for 30,000 self-indicating ionization-chamber dosimeters. The units, which sell for approximately $10 apiece, will be stockpiled throughout the country for emergency purposes.

Bell Telephone has available its bell-and-lights air-raid warning system. It consists of a special telephone dial, located at a central control point, connected by private one-way telephone circuits to any number of bell-and-lights signal boxes, at warning points. One turn of the control dial flashes warning signals and sounds to all warning points. Bell also supplies two-way radio equipment which it leases and maintains.

Alden Electronics & Impulse Recording Equipment Co. has facsimile equipment available for civil defense use.

Set Prices Go On The Upgrade

Set makers revise prices upwards in face of rising labor and materials costs

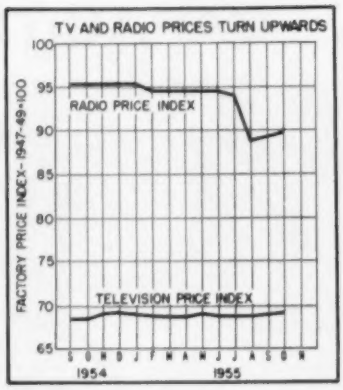
NEARLY every major tv-set manufactured has increased receiver prices in the past few months causing an average rise of $10 in the retail price of many models. According to set makers, the rise is due to increasing costs of material and labor.

► **Chart**—Trend of radio and tv factory prices over the past year is indicated by the government's wholesale price indexes for the products which cover factory prices. Latest figures are beginning to show recent tv price increases. They may also indicate that more higher price sets are being sold.

The radio index shows recovery from the sharp drop that took place in August.

► **TV Price Drops**—Every year since 1947 the average retail price of tv receivers has fallen. Last year it took one of its biggest drops, a $50 decline from $280 to $230. The decline is expected to continue this year despite recent price increases, but it may not be as severe.

Manufacturers have emphasized lower priced sets for the second set market. Large-screen sets priced below $100 are reported to be selling well. Indications are that a greater proportion of total set sales this year will be in table models than last year. In June the ratio stood at 60 percent table models and 40 percent consoles.



► **Radio Down Too**—Radio receiver prices have also followed a downward path over the years. In 1954, average retail prices declined by about $3 from 1953. The drop in the U. S. wholesale price index for the product in August indicates that the decline will be much more severe this year, despite the upward trend of the last few months.

Glass Makes Headway In Resistors

JUST about a year has passed since low-power glass resistors first became available for use in radio and television receivers. In that time a dozen tv manufacturers have adopted the component for use in current sets and another has the units on order.

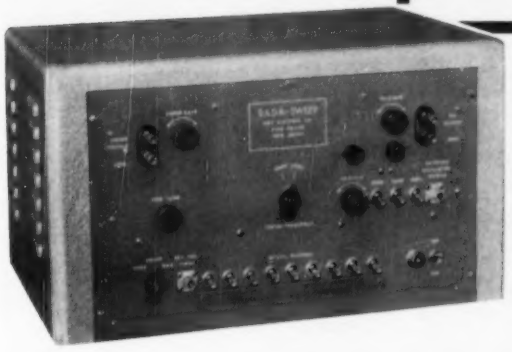
► **Why**—Glass resistors have been used in specialized military electronic equipment, but cost was prohibitive for civilian consumer goods. It was not until low-cost low-power types with 3, 4 and 5-watt ratings were introduced that volume use began. Now prices of the units, depending on size, range from 30 cents to $1. In quantities the price is lower. In some cases these lower prices have forced price adjustments in the conventional resistor field.

► **Construction** — The low-power resistors are made of a film of metallic oxides bonded to a Pyrex glass rod under heat. By means of electronically controlled machines, the film is automatically cut to the proper value and as-

(Continued on page 28)

KAY

Wide Band Sweeps for Aligning Radar IF Amplifiers



A combined sweeping oscillator and crystal marker generator, the Rada-Sweep is designed especially for rapid alignment of radar IF amplifiers. Used with an oscilloscope, it will display response curves of IF amplifiers and mark up to nine frequencies to allow precise adjustment of response.

KAY *Rada-Sweep*

SPECIFICATIONS

Center Frequencies: 30 and 60 megacycles. Others may be added to special order.

Sweep Width: Wide—20 mcs or Narrow—3 mcs selected by a panel switch.

Sweep: All electronic, linear sawtooth. Sweep signal is brought out to terminals for connection to oscilloscope horizontal amplifier. Sweep repitition rate is adjustable around and may be synchronized to the cps line.

Markers: Up to 9 crystal positioned pulse type marks fed directly to scope vertical amplifier. Four supplied standard at 25, 35, 55 and 65 mcs. Others located as specified by purchaser. The standard marks may be replaced with others as specified. Individual on-off control of each mark.

Amplitude Modulation While Sweeping: Less than .05 db/mc.

RF Output Voltage: 250 millivolts across 70 ohms.

RF Output Control: Switched Attenuator: 20 db, 20 db, 10 db. Continuous Attenuator: covers approximately 5:1 ratio.

Marker Output Voltage: Positive pulse, approx. 10 V peak.

Marker Output Control: Continuously variable, 0 to maximum.

Power Supply: 105 to 125 volts, 50 to 60 cps. Power input approximately 100 watts. Circuit electronically regulated.

Price: $395.00 f.o.b. plant with standard marks. Any standard mark may be replaced with a special frequency—$10.00 each. Additional marks at $20.00 each.

The Radaligner is a two-band sweeping oscillator designed to be used with a standard oscilloscope to determine frequency response of circuits from 10 to 170 mc. For frequency identification, the Radaligner includes eight narrow, cuustomer-specified, crystal-controlled markers and a single variable marker covering both sweeping oscillator ranges. Center frequencies of sweep ranges also set to customer's requirements.

KAY *Radaligner*

SPECIFICATIONS

Sweep: Regular sawtooth, adjustable around or synchronized with 60 cps power line.

Frequency Range: Center frequencies may be selected at any two points in the 10 to 170 mc band.

Sweep Width: Center Frequency below 30 mcs: ±5 mcs Wide Band, ±0.5 mc Narrow Band; Center Frequency above 30 mcs: ±10 mcs Wide Band, ±1.5 mcs Narrow Band.

Amplitude Modulation While Sweeping: Less than 0.05 db/mc.

RF Output Voltage: 250 millivolts into 70 ohms.

RF Output Control: Switched attenuators: 20 db, 10 db and 3 db. Continuous attenuator: approximately 6 db.

Markers: Fixed: Eight, narrow pulse-type, crystal-controlled markers, positioned at customer's option. Available singly or in any combination through individual switches.
Variable: Frequency continuously variable throughout selected sweep ranges. Frequency calibration accurate to within 0.5%.

Marker Output Voltage: Positive pulse, approximately 10 volts peak.

Marker Output Control: Continuously variable, zero to maximum.

Power Requirements: 105 to 125 volts, 50-60 cps, approx. 110 watts.

Price: $795.00 (rack-mounted), f.o.b. plant. Cabinet $35.00 extra.

For complete information write:

KAY ELECTRIC COMPANY

DEPT. E-12 14 MAPLE AVENUE PINE BROOK, N. J.

sembled with caps and leads.

Corning Glass, makers of the low-power units, has formed a components department to handle increased business from the electronics industry.

Financial Roundup

Many companies rack up record net profits for 1955's first nine months

THIRD quarter profits for many companies in the electronics field helped to boost nine month's earnings to new highs. Following are the net profit reports of 23 companies for the fiscal periods indicated:

Company	Net Profit 1955	1954
Avco 9m	$63,801	$3,336,721
Borg-Warner 9m	26,076,149	14,052,304
Burroughs 9m	8,255,002	6,922,436
Clevite 9m	3,219,431	1,980,501
T. A. Edison 9m	900,162	500,873
Elgin Watch 6m	268,446	269,648
Garrett 3m	1,093,000	840,000
General Controls 9m	1,156,664	717,237
General Electric 9m	141,359,000	136,191,000
Hoffman 9m	924,292	1,139,421
Magnavox 3m	564,807	331,729
Minn. Mining 9m	24,685,380	17,308,226
Motorola 9m	4,885,848	4,590,067
Philco 9m	4,854,000	2,275,000
Precision Instruments 9m	496,658	122,835
RCA 9m	30,995,000	27,557,000
Standard Coil 9m	304,753*	1,912,279
Stewart-Warner 9m	4,345,959	1,831,719
Sylvania 9m	9,556,210	6,166,226
Texas Instruments 9m	1,099,748	811,842
Tung-Sol 9m	2,286,511	1,478,493
Varian Assoc 12m	433,000	225,000
Webster-Chicago 9m	691,476	236,894

*(loss)

► **Securities** — Pyramid Electric filed with SEC covering 35,000 shares, par $1, to be issued against warrants, at $3.25 per share. Net proceeds are to be used for general corporate purposes.

RCA registered with SEC covering $100 million of 25-year convertible subordinated debentures to be offered to its common stockholders. They will be offered in the ratio of $100 principal amount for each 14 shares of common stock held of record. The offering will represent the first public financing by the company. Proceeds will be used for working capital, property additions and improvements and for further expansion of facilities.

FUTURE MEETINGS

DEC. 12-16: Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council, Cleveland, Ohio.

DEC. 14: IRE Operations Research Symposium, University Museum, University of Pennsylvania, Philadelphia, Pa.

DEC. 15-17: URSI Fall Meeting, University of Florida, Gainesville, Fla.

JAN. 9-10, 1956: Second National Symposium on Reliability and Quality Control In Electronics, ASQC and RETMA, Hotel Statler, Washington, D. C.

JAN. 18-20: 12th Annual Technical Conference, Society of Plastics Engineers, Hotel Statler, Cleveland, Ohio.

JAN. 19-21: IRE National Simulation Conference, AIEE, ACM, Baker Hotel, Dallas.

JAN. 25-26: Third Annual Industrial Show, Penn Sherwood Hotel, Philadelphia, Pa.

FEB. 2-3, 1956: IRE National Symposium on Microwave Techniques, University of Pennsylvania, Philadelphia.

FEB. 9-11: IRE Southwestern Regional Conference and Show University of Pa. Philadelphia, Pa.

FEB. 15-17: 1956 Conference On High-Speed Computers, Louisiana State University, Baton Rouge, La.

FEB. 16-17: IRE, AIEE, Univ. of Pa. Conference on Transistor Circuits, University of Pennsylvania, Philadelphia, Pa.

FEB. 28-29: Scintillation Counter Symposium, IRE, AIEE, Shoreham Hotel, Washington, D. C.

MAR. 19-22: IRE National Convention, Waldorf-Astoria Hotel, Kingsbridge Armory, New York, N. Y.

APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.

APRIL 10-12: Twelfth Annual Meeting and Metal Powder Show, Hotel Cleveland, Cleveland, Ohio.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.

APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston, Mass.

Industry Shorts

► **Total** of eleven f-m subsidiary communications authorizations have been approved by the FCC.

► **Market** in batteries for transistorized radios will reach $100 million in three years, according to Olin Mathieson Chemical Corp.

► **Small** airborne Pye tv camera has been used to observe deicing tests on Britannia airliner engines.

► **Selenium** shortage continues and the government is again urging tv and radio repairmen to salvage discarded selenium rectifiers.

► **New** techniques of broadcast transmission which use the scatter principle make possible the immediate establishment of tv relay stations linking America and Europe, according to Allen B. Du Mont.

► **Latest** Admiral tv sets have three automated printed circuits equivalent to 80 percent of all the wiring in the set.

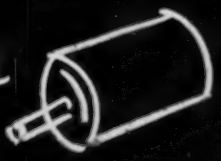
► **Color** film-scanner shipments total 63 units to 59 stations.

► **Two** contracts to apply the principle of acoustic interference (electronic sound absorption) to military problems have been undertaken by RCA.

► **General** Electric now employs some 16,000 people in the electronics field in central New York state alone, with an annual payroll of

(Continued on page 30)

G-M Servo Motors



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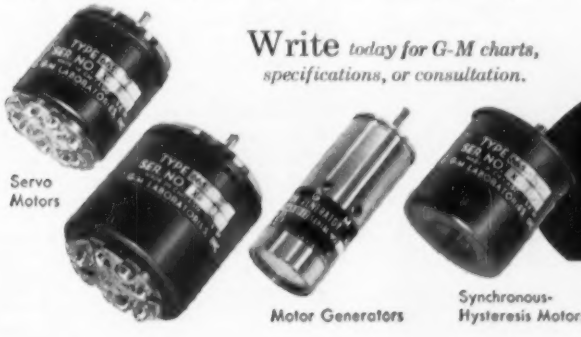
TO MEET ALL MIL. ENVIRONMENTAL SPECIFICATIONS

By specializing in servo motors only—not systems—G-M gives you these advantages...

- A broader line of servo motors in sizes and types to meet a wide range of applications.
- Servo motors available in *all* the standard sizes.
- Standard sizes specially modified to meet specific circuit requirements—available on a quick-service basis.
- Creative engineering in designing special motors with special characteristics.
- Faster production—better service.

When reliability under extreme conditions is essential—specify G-M Servo Motors! G-M has long specialized in supplying precision servo motors to the Military Avionic Industry, especially designed to meet military specifications for humidity, salt spray, temperature, vibration and altitude. Whatever your needs, let G-M build a servo motor with the *right* characteristics to perform to your specifications.



Servo Motors

Motor Generators

Synchronous-Hysteresis Motors

Write *today for G-M charts, specifications, or consultation.*

GM

G-M Servo Motors

manufactured by the Components Division of

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between $76 to $80 million, according to R. J. Cordiner, president.

▶ **Single-sideband** for all mobile, Alaskan and maritime fixed service radiotelephone below 25 mc is under consideration by FCC to help provide more communications channels.

▶ **Production** of tv sets in Germany is expected to reach 350,000 this year and may rise to 1.2 million sets by 1958, according to Telefunken.

Industry Report Index

Aircraft
Air force long-distance circuits use vhf ..... 7 Nov
Automatic pilot sales ..... 16 Feb
Civil air patrol radio ..... 20 Jul
Private-plane market ..... 20 May
Radar folds into floor ..... 24 Jun
Radar network link ..... 16 Oct
TACAN ..... 7 Oct
Trainer business ..... 14 Apr

Audio
Diamond-needle market ..... 20 Jan
Juke box business ..... 14 Jul
Magnetic recording markets ..... 12 Jul
Mobile high fidelity ..... 16 Dec
Taped music future ..... 22 Sept

Broadcast
A-M and tv broadcasters make progress ..... 12 Jun
Armed forces tv ..... 16 Jun
Broadcasters add up 1954 tv business ..... 6 Aug
Broadcasters focus on color ..... 10 Jul
Commercial tv for Britain ..... 24 Sept
Educational tv ..... 22 Sept
F-M subsidiaries may subsidize f-m ..... 22 Jun
Networks plan more color ..... 16 Sept
Soundcasting continues profitable ..... 12 Jan
Soundcasting stations cover nation ..... 24 Feb
TV shows in every state ..... 24 Apr
TV transmitter market ..... 14 Apr

Business and Finance
Arizona state tax ..... 14 Aug
Arizona wants electronics plants ..... 16 Jun
Auto and parts firms feature electronics ..... 22 Sept
Bankers pronounce industry healthy ..... 7 Jun
Big business' stake in electronics ..... 22 Aug
Community tv growth ..... 12 Jul
Electronics assets climb ..... 20 Apr
Electronics booms in west ..... 22 May
Electronics firms in nuclear power ..... 6 Apr
Electronics in business ..... 24 Dec
Electronics industry spreads out ..... 14 Aug
Electronics in Massachusetts ..... 20 Nov
Electronics profits gain ..... 6 May
Factory inventories high ..... 20 Oct
Fewer firms failed in 1954 ..... 24 Aug
Flooded industries bounce back ..... 16 Oct
Industry future holds $20 billion ..... 12 May
Industry grows ..... 16 Nov
Industry shows mixed record ..... 20 Sept
Infrared scopes go commercial ..... 24 Sept
Los Angeles updates progress ..... 20 Apr
Maintenance is $10-billion business ..... 24 Apr
Manufacturers display 1955 models ..... 24 Feb
Microwave ovens in home kitchens ..... 22 May
Operations research gains ..... 14 Dec
Parts distributors grow ..... 14 Jan
Plant expansions ..... 20 Aug
Productivity gains in industry ..... 12 Sept.
Reactors expand electronics ..... 12 Sept
Transistor wrist radio ..... 10 Dec
Transistor's future ..... 14 Nov
Transistors in consumer products ..... 12 Jul
Transistors progress ..... 6 Jul
Tube machine makers big year ..... 22 Dec
Tubes process checks ..... 24 Jul
Tubes show tubes on tv ..... 12 May
TV and radio get set for summer ..... 10 Jul
Ultrasonic processing in three markets ..... 12 Feb
Ultrasonics gains ..... 14 Mar
U. S. budget jets electronics spending ..... 20 Mar
What's ahead for the remainder of 1955 ..... 14 Sept
What it takes to be an executive ..... 24 May
Foreign
Electronics in France ..... 22 Jul
Japanese transistor portable ..... 12 Oct
Offshore purchases bolster Europe's plants ..... 22 Feb
Puerto Rican boom ..... 7 Jul
TV output in Canada ..... 16 Mar
U. S. electronics at German fair ..... 24 May
West German industry ..... 22 Feb
Sales
Dry-cell business ..... 10 Feb
Gas-tube shift ..... 22 Oct
Industry volume for 1954 ..... 20 Feb
Industry looks at 1955 ..... 24 Jan
Klystron business ..... 16 Sept
Magnetic amplifier sales ..... 14 May
Magnetron sales ..... 14 Feb
Manufacturers eye selling costs ..... 10 Jun
New transistor radio ..... 7 Jun
Orthicon output ..... 10 Sept
Phototube sales ..... 10 Apr
Renewal market gains ..... 16 May
Transistor portables ..... 10 Feb
Traveling-wave tubes ..... 22 Jun
TV manufacturers appraise 1955 ..... 8 Feb

Communications
Businessmen adopt citizens' radio ..... 16 Aug
Facsimile sales ..... 16 Apr
Microwave relay business ..... 24 Sept
More two-way radio ..... 22 Jan
Radar helmet ..... 16 Oct
Radio aids flood-stricken east ..... 12 Oct
Radio replaces cable ..... 14 Nov
Robot op takes code at 600 wpm ..... 24 May
Sun powers telephone line ..... 20 Nov
Taxi radio market ..... 20 Jun
Transistors aid long distance calls ..... 26 Apr
Yachtsmen boost electronics ..... 22 Mar

Computers
Analog computers help design brakes, missiles ..... 16 Sept
Build-it-yourself computer ..... 14 Nov
Computers cut machining costs ..... 24 Oct
Computer controls inventory ..... 20 Aug
Computer firms report gains ..... 20 Oct
Computer manufacturer presses 1,000 mark ..... 8 Sept
Computer men scan low-price field ..... 20 Jan
Computers seek new fields ..... 10 Nov
Computers improve operations ..... 10 Feb
Engineers humanize computer ..... 8 Jan
Magnetic memory goes juke box ..... 10 Jun
More small computers appear ..... 8 Dec
New computer models ..... 12 Apr
Personal paging business ..... 16 Dec
Specialized computers ..... 14 Mar
Transistor computer ..... 7 May

Government
Government probes mergers ..... 14 Jul
U. S. contract awards emphasize radar ..... 22 Oct
U. S. urged to increase surplus disposal ..... 12 May
Federal Communications Commission
FCC asks military for vhf channels ..... 10 Nov*
FCC estimates its budget ..... 12 Feb
FCC looks at tv competition ..... 14 Dec*
FCC moves in on ultrasonics ..... 25 Apr
FCC okays low-power television ..... 22 Aug
FCC reveals mobile radio use ..... 16 Apr
Mack named to FCC ..... 24 Aug
NAM wants in mobile radio ..... 12 Mar
Toll television ..... 16 Jul

Industry
Auto industry eyes electronics ..... 12 Aug
Electronic headlight dimmers ..... 22 Nov
Electronics in atomic energy ..... 8 Dec
Electronics in chemical plants ..... 10 Oct
Electronics gains in movies ..... 22 Apr
Fire alarms go radioactive ..... 22 Jun
Industry plans spending for '56 ..... 10 Dec
Industry stresses reliability ..... 8 Jun
Machine makers go electronic ..... 14 Nov
More locomotives use rectifiers ..... 24 Oct
Oil firms team with electronics ..... 14 Jun
Oil industry goes automatic ..... 22 Aug
Punch cards batch concrete mixer ..... 20 Jun
Subminiature relays in industry ..... 24 Dec
Tones control plant services ..... 20 Apr
Tubes in metal trades ..... 20 May
Tubes moving underground ..... 24 Jun
Tubes in tool industry ..... 10 Aug

Materials
Copper prices soar ..... 14 Oct
Dwindling selenium conserved ..... 10 Oct
Glass in resistors ..... 26 Dec
Glass makers push parts-fields invasion ..... 14 May
Synthetic mica output ..... 24 Jan
Wiring board hypo plastic sales ..... 10 May

Military
Air force backs industry ..... 8 Jul
Air force plans parts handbook ..... 22 Mar
Army buys transistor transceiver ..... 12 Sept
Civil defense fosters electronics sales ..... 26 Dec
Civil-defense helmet ..... 22 Jan
Defense department wants more reliability ..... 24 Nov
Defense in Canada ..... 20 Nov
DEW line radar ..... 10 Apr
Early warning radar goes airborne ..... 10 Jan
Electronics military contracts ..... 8 Aug
Flat-top sounds off with tubes ..... 24 Nov
Hurricanes speed radar islands ..... 8 Sept
Industry holds share of defense buying ..... 8 Nov
Military to give navaids business ..... 26 May
Military probes spurious radiations ..... 7 Apr
Missiles business shoots up ..... 14 Sept
Navy sees $7.0 billion for 1955 ..... 7 Aug
Radar platform ..... 16 Jul
Robot aerial camera inspection ..... 7 Dec
Small business gains military work ..... 12 Dec
Transistors in military equipment ..... 20 Dec
Twenty-MM transmitter ..... 14 Jan

Personnel
Engineers guide missile design ..... 7 Apr
Mock reactor trains engineers ..... 16 Oct
Supply of technicians ..... 24 Mar

Production
Automatic machine wires chassis ..... 8 Oct
Electrolytic capacitor output ..... 14 Jun
Mechanized assembler builds computers ..... 8 Mar
Mechanized production takes hold ..... 20 Feb
New tv sets utilize automatic production ..... 7 Jul
Parts makers try new packaging ..... 20 Mar
Robot assemblers coming soon ..... 14 May
Tape controls panel hole pattern ..... 16 Mar

Research and Development
Complex scope patterns form art studies ..... 24 Jul
Electronic cooler ..... 10 Mar
Electronics and atomic blast ..... 14 Dec
Electronics aids space station ..... 7 Sept
Electronics revives Aladdin's lamp ..... 20 Jul
Electronics withstands nuclear explosion ..... 20 Sept
Finder accelerates tetrode transistor production ..... 12 Mar
Hollow tubes carry conversations ..... 22 Mar
Magnistors promise to supplement transistor ..... 10 May
Microwave cooking ..... 12 Dec
Moving engine x-rayed with itv and betatron ..... 20 Mar
Music synthesizer ..... 24 Mar
Phosphor sandwich brightens pix ..... 12 Feb
Research buys testing gear ..... 12 Nov
Research heads for billion mark ..... 22 Dec
Research radio stations ..... 8 Oct
Testing laboratories use electronics ..... 22 Apr
Transistor quality improves ..... 16 Mar
Transistor radio details ..... 26 Feb
Transistor transmitter ..... 24 Nov
Transistor uhf tetrode ..... 7 Sept

Television
Aluminized tubes ..... 16 Jan
Bundling cuts cost ..... 12 Nov
Medical television ..... 24 Oct
More industries use itv ..... 14 Oct
New markets for television ..... 24 Dec
New tube materials ..... 16 Nov
Set prices increase ..... 26 Dec
Submarine tv checks fish nets ..... 26 Mar
Wall-mounted tv picture tubes ..... 7 Feb
Why television sets fail ..... 20 Dec
Color
Color bulbs go conventional ..... 22 Nov*
Color set makers get set for '55 ..... 14 Jan
Color-tube design ..... 8 Nov*
Color tube output ..... 16 Aug
Color tv warms up ..... 7 Dec*
Economy forecast for color camera ..... 16 May
Europeans to study U. S. standards ..... 7 Nov*
More setmakers move into color ..... 7 Oct
Projection receiver enters color field ..... 7 Jan
Push for color tube output ..... 7 May
Tape used for color tv ..... 8 Jun
Taped color moves toward market ..... 12 Apr

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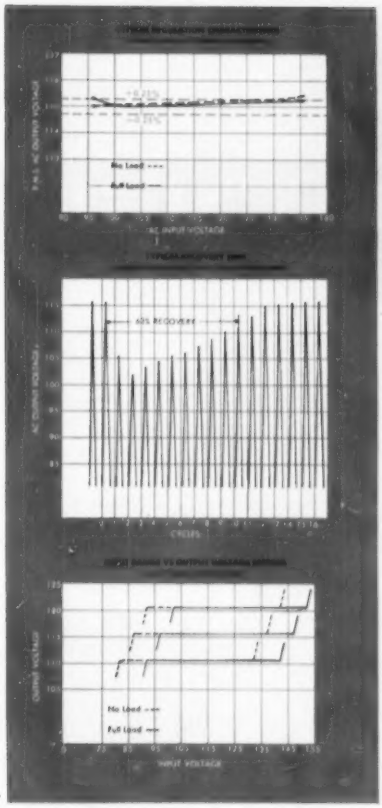

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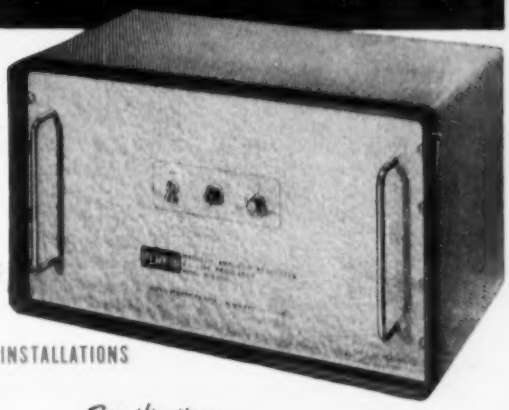

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- **Input Voltage Range:** 95 to 135 volts
- **Output Voltage:** Nominal 115 volts, can be adjusted from 110 to 120 volts.
- **Output Current:** 8.5 amperes
- **Regulation Accuracy:** ±0.25% for any combination of line or load
- **Frequency Range:** 60 cycles ±10%
- **Wave Form Distortion:** 3% maximum
- **Power Factor Range:** 0.5 lagging to 0.9 leading
- **Response Time:** 0.2 sec.
- **Maximum Load:** 1.0 KVA
- **Ambient Temperature Range:** Up to 45° C.
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- **Finish:** Gray Hammertone
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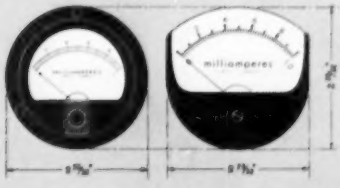

Comparison of Medalist and Standard Style

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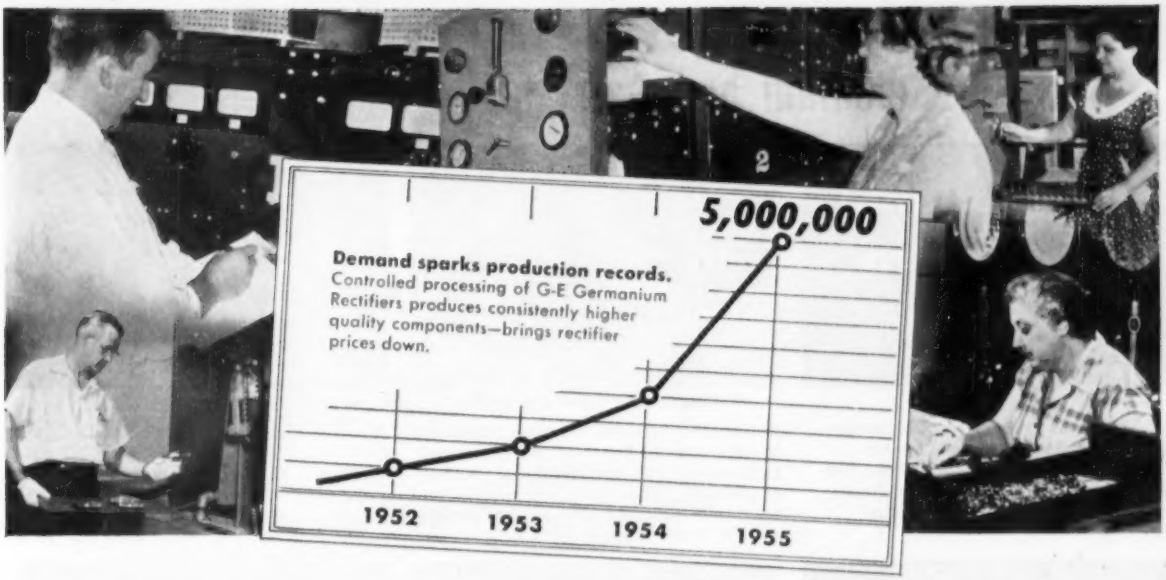

G-E Germanium Rectifier Production Breaks the 5 Million Mark

Customer requirements accelerate the production of a full line of highly reliable, long-life germanium rectifiers

THE NEW germanium rectifiers were introduced by General Electric in 1952 and since then more than 5 million units have been produced for industrial and military needs. In effect, this achievement represents more than *ten billion hours* of rectifier life—in hundreds of diversified commercial and military applications.

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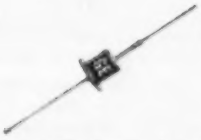
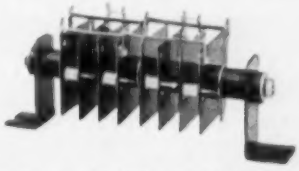
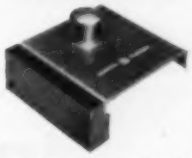


Diffused Junction Germanium Rectifiers combine very high forward conductance with very high back resistance. The high temperature and magnetic amplifier rectifiers feature very low reverse current ratings at ambient temperatures of 85°C.



Power of the basic rectifier unit is boosted 5 times by adding a copper fin. Stacked one to twelve fins in series or parallel, the rectifier may be operated as half wave, full wave, or bridge circuits, and many other types of single or polyphase circuits. Typical power ratings are as high as 3 amps @ 190 volts; 1.3 amps @ 575 volts; 3.6 amps @ 140 volts, etc.



The Medium Power Rectifier has a 5 amp rating at 200 volts (55°C). At 85°C it is rated 2.5 amps at 100 volts. These rectifiers, stacked in series or parallel, have ratings in thousands of watts depending on the design of the circuit.

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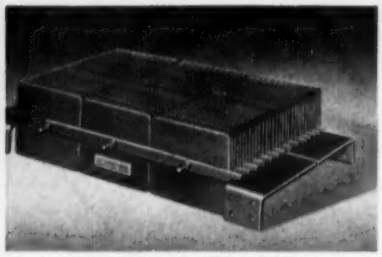

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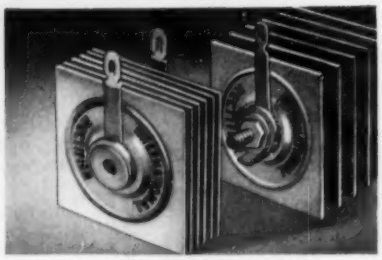

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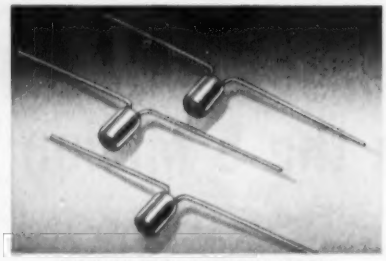
Designed for long life and reliability in Half-Wave, Voltage Doubler, Bridge, Center-Tap Circuits, and 3-Phase Circuit Types. Phenolic Cartridge and Hermetically Sealed types available. Operating temperature range: −65°C to +100°C. Specify **Bulletin H-2**



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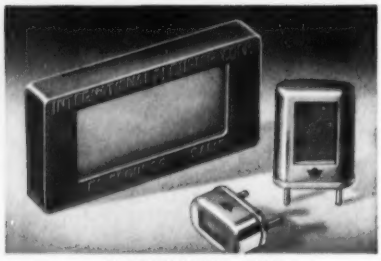
Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. **Bulletin SD-1B**



PHOTOELECTRIC CELLS

Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC 649**

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High quality units of improved design are the results of years of experience in the production of exceptionally fine germanium crystals plus extensive research, development and field performance testing!

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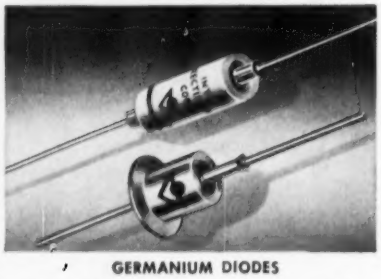

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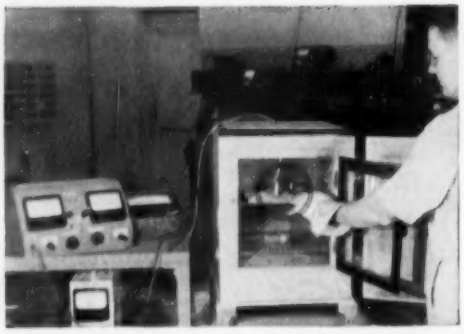
TWENTIETH CENTURY Relay

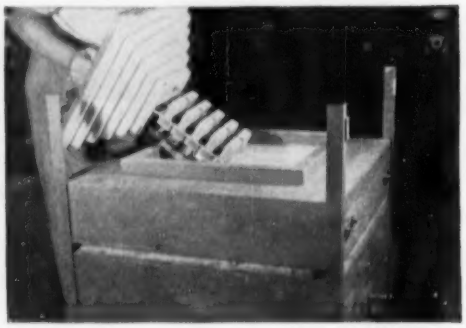
The Potter &



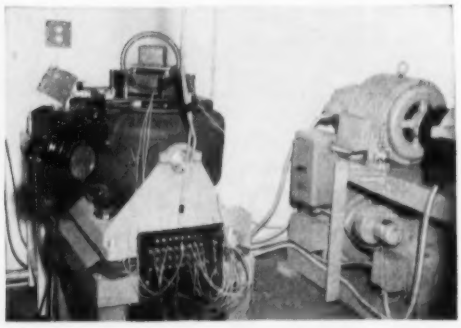
Relays operating in special constructed ovens are subject to temperatures exceeding 400° Fahrenheit. Recording instruments indicate any malfunction.

One of the reasons that keeps Potter & Brumfield Relays out in front.
The best Engineering design is not enough.
Prototypes must pass all torture qualification tests.
More important the manufactured product must meet engineering expectations. Not just now and then, but for as long as the relay is made.
That is why Potter & Brumfield relays are tortured regularly throughout production runs.

POTTER & BRUMFIELD



Frost covered sealed relays are taken from especially designed sub-zero chamber which has subjected them to continuous operation at —100° Fahrenheit.



Shaker and power supply located in soundproof room has frequency range of 0 to 2000 C.P.S. Complete with automatic servo control of acceleration and frequency cycler.

ALL TYPES—ALL SIZES—FOR ALL APPLICATIONS

Torture

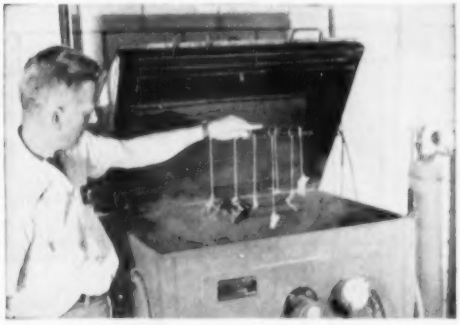
Brumfield Way

Different relay designs are subjected to torture tests in varying degrees.
Potter & Brumfield builds relays to all quality levels and at the best possible price to you.
Samples available for immediate delivery. Send your specification for recommendation and quotations.

For quick delivery over 350 different standard relays stocked by 500 Franchised Electronic Parts Distributors throughout the United States and Canada.

Typical rugged life test using a series of 1000 watt lamps causing the relay to operate under a load 10 times more severe than normal.

PRINCETON, INDIANA



Control of metal finishes are a must for accurate relay operation. Parts are periodically subjected to a minimum 20% salt spray to check their resistance to corrosion.

Tester built to JAN specifications provides shock of over 100 G's. Contact reactions are indicated on oscilliscopes—thyratrons or other special equipment depending on speed.

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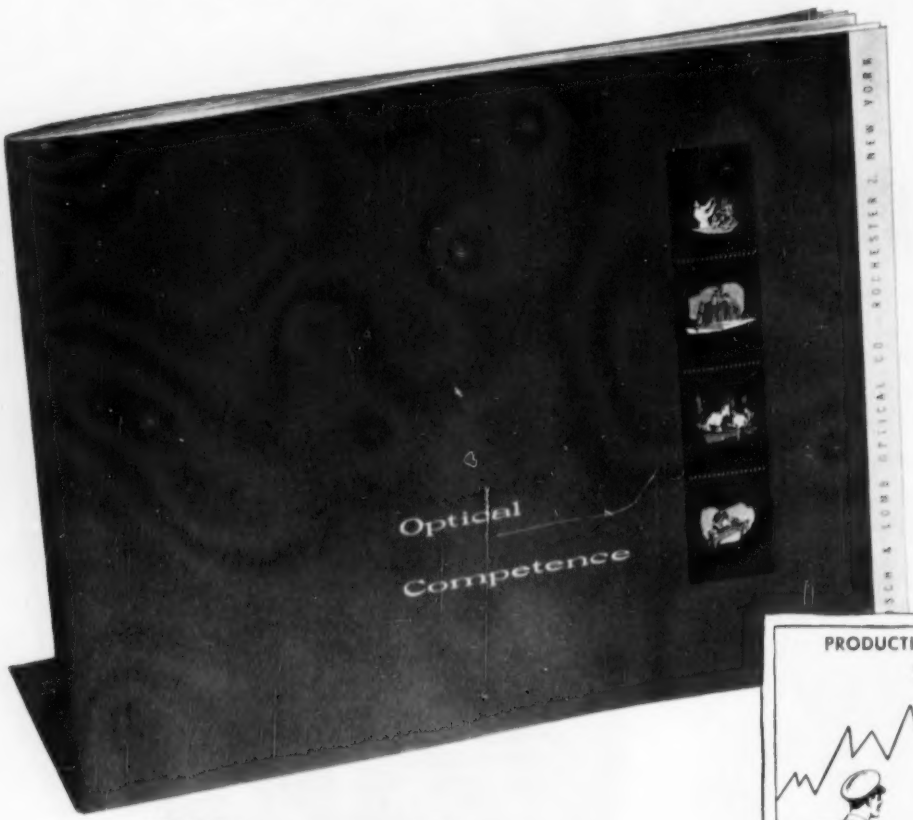

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ERIE PAC Facts

- **Cost Savings**
  Fewer insertions
  Simplified insertion equipment
  Fewer items purchased
  Fewer chassis holes
  Smaller chassis
  Reduced inspection
  Simplified chassis wiring

- **Simplified Circuit Design**
  Design engineers can determine optimum parameters by quick, easy component "snap-in" kit, simulating actual final layout.

- **Easy Circuit Changes**
  Component value changes facilitated by simple assembly program variation. Modest circuit modification costs.

- **Flexibility**
  All resistance values between 5 ohms and 50 megohns. All capacitance values between 1 mmf and 5100 mmf. Parallel and series arrangements readily obtained. Excellent Circuit Flexibility thru use of printed wiring type base.

- **Isolated Components**
  Low shunt capacitance due to low K base.

- **Close Tolerances**
  Resistors as close as ± 5%.
  T.C. capacitors as close as ±1% or ±.1 mmf.

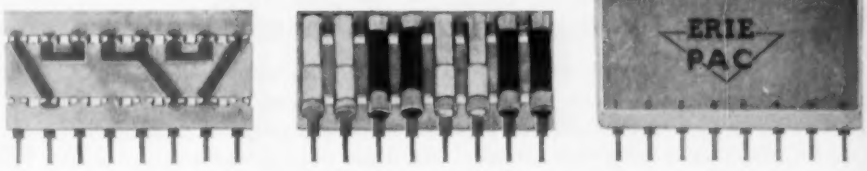
- **Ruggedness**
  Reduced breakage. No pulled-off terminals.

- **Reduced Chassis Area**
  15 components per square inch — achieved by mounting "PAC" in vertical plane.

- **Low, Uniform Strays**

PAC*

ERIE'S New Simplified Automation *PIN ASSEMBLY CIRCUIT Lowers TV Costs



TYPICAL CIRCUIT — ACTUAL SIZE

The Pin Assembly Circuit "PAC" simplifies automation for the electronic industry by the grouping of components such as resistors and capacitors into a unitized modular package for quick, accurate installation. Packaging a group of components greatly reduces assembly labor costs. This is the real key to *lower cost television sets*, radios, computers, controls and other electronic items, both commercial and military.

Based on uniform "building block" components, having a ⅛" diameter and a ⅝" length, the Pin Assembly Circuit combines up to 92 individual components in one package. Thus, in a conventional 21" television receiver, all resistive and capacitive elements can be included in just a few "PAC" modules. This means a considerable reduction in cost of assembly labor and equipment, whether modules are assembled to the chassis by hand or by automatic equipment.

Write for Erie Engineering Bulletin #450.

ERIE electronics

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ERIE RESISTOR CORPORATION
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The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

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We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.

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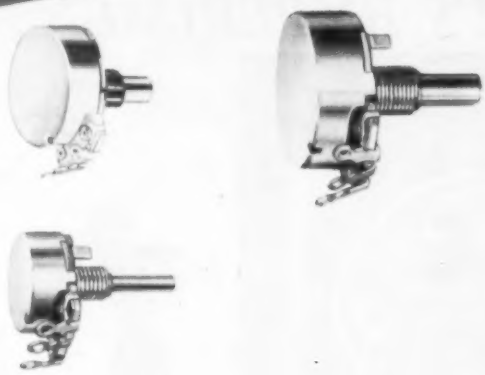

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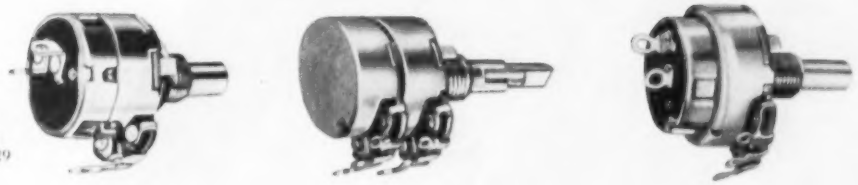

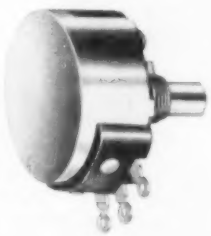

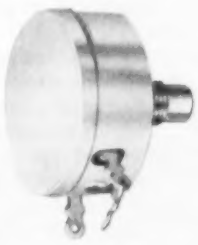

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THIS KIT CONTAINS THE FOLLOWING 10 JFD PISTON CAPACITORS WITH THE CHARACTERISTICS INDICATED BELOW.

MODEL	CAPACITY RANGE MMF	OPERATING TEMPERATURE RANGE °C	TEMPERATURE COEFFICIENT 1KC P.P.M./°C	Q at 1MC	DIEL.	MOUNTING THREAD SIZE
VC5	.5 to 5	−55° to +200°	Approx. 0	1800	Fused Quartz	¼ – 28
VC11	1 to 10	−55° to +200°	Approx. 0	1800	Fused Quartz	¼ – 28
VC12	10 to 20	−55° to +200°	Approx. 0	1200	Fused Quartz	¼ – 28
VC1G	.5 to 8	−55° to +125°	+50 ±50	600	GLASS	¼ – 28
VC3G	.7 to 8	−55° to +125°	+500 ±100	600	GLASS	¼ – 28
VC4G	1 to 18	−55° to +125°	+500 ±100	700	GLASS	¼ – 32
VC8G	1 to 8*	−55° to +125°	+50 ±50	700	GLASS	¼ – 28
VC11G	.7 to 12	−55° to +125°	+50 ±50	700	GLASS	¼ – 28
VC13G	1 to 10	−55° to +125°	+400 ±100	625	GLASS	¼ – 28
VC30G	1 to 30	−55° to +125°	+100 ±50	600	GLASS	¼ – 28

*For complete physical and electrical data see Engineering Bulletins.

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because it is uniform, offers better

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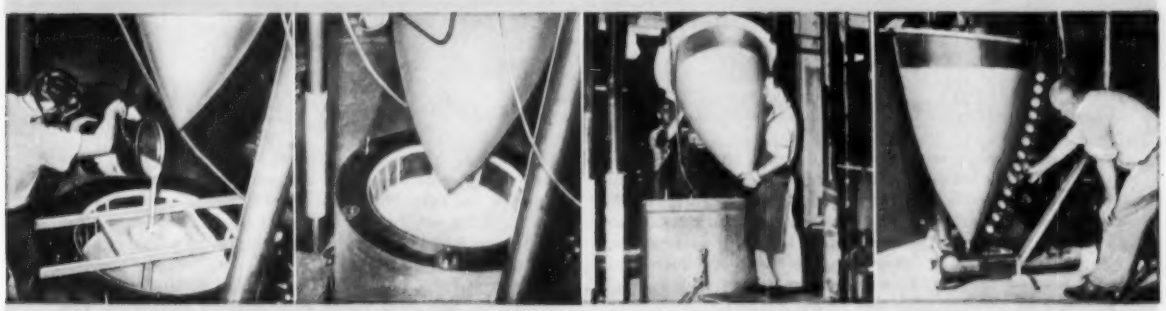
single-jet, carrier-based fighter plane made by McDonnell Aircraft Corp., St. Louis, Mo. The "Demon" is an all-weather, high performance fighter combining interceptor speed and fighter maneuverability with the payload of an attack bomber. It utilizes the latest in electronic aiming devices. The high precision radome—one of the largest in commercial production—is made for McDonnell by The Brunswick-Balke-Collender Co., Plastics Division, Marion, Va.



Sequence of photographs showing Nopco Lockfoam being poured into the mould—where it solidifies in a matter of minutes—removed as the finished radome, and inspected. These show some of the reasons for Brunswick's statement that with Lockfoam they have been able to reduce the man-hours needed.

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Where you find the most modern in construction, you are very apt to find Nopco Lockfoam being used. And that goes not only for aviation and electronics manufacture, but in many other industries as well. Airplane radomes are but one of the first conspicuous applications which are using to good purpose Lockfoam's excellent electrical properties, its strength-weight ratios, plus Lockfoam's ability to fill exactly the configurations of any cavity into which it is poured.

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Where huge savings in time and costs will be realized!

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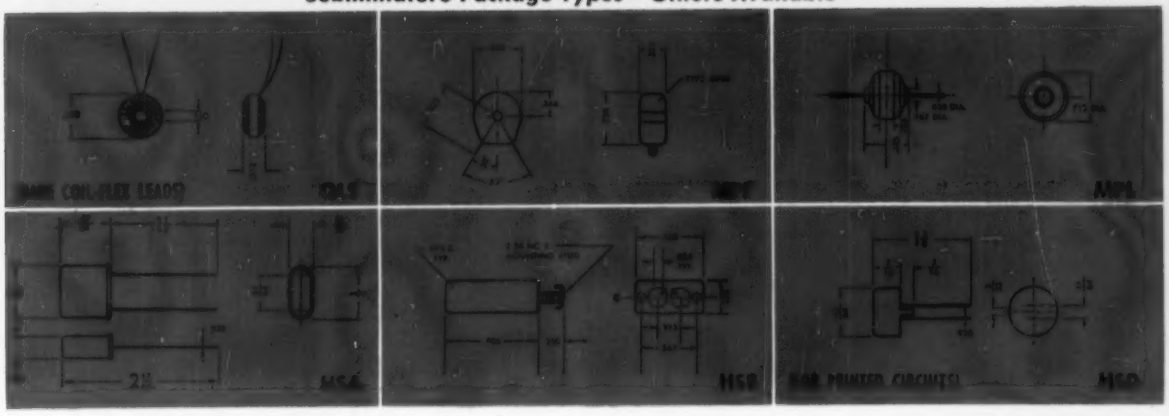

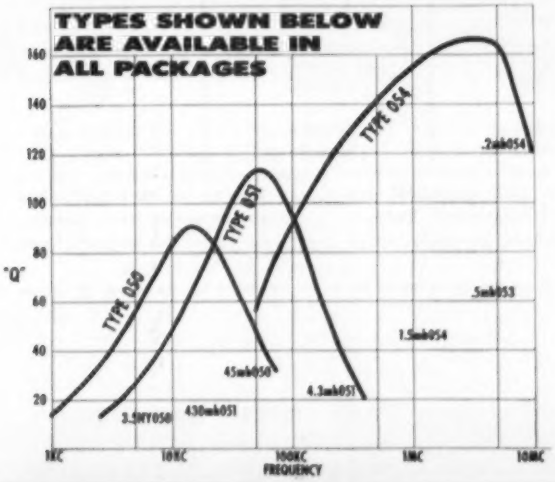

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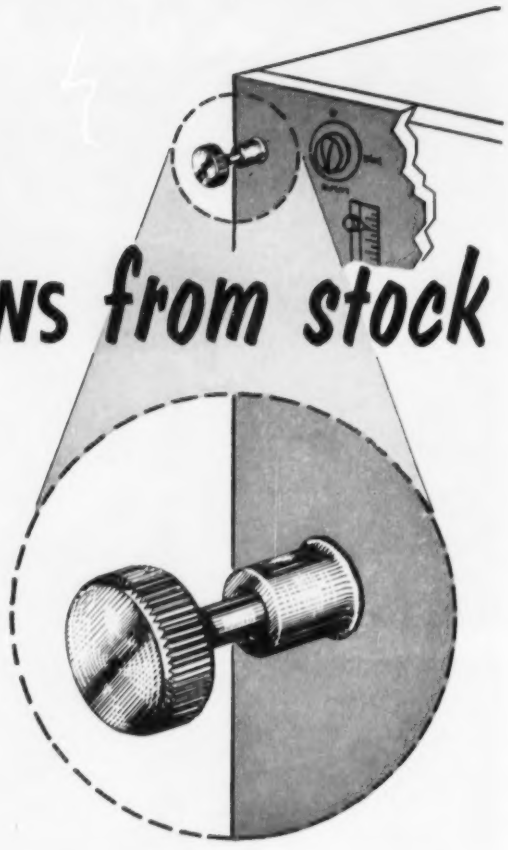


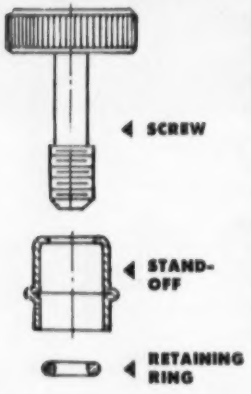
Here's a low-cost retractable screw fastener to save you assembly time and to eliminate the frequent need for costly special design fasteners. Unmatched for fast, economical use by assemblers of electronic units and other paneled cabinets.

"Floating" screw insures easy alignment no matter how many screws are engaged in a single panel. No special skills or tools needed; installation fast and simple.

3 head sizes and 3 standard thread sizes available. On special order, slotted heads, stainless steel screws, and extra long screws.

Write for complete information. Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

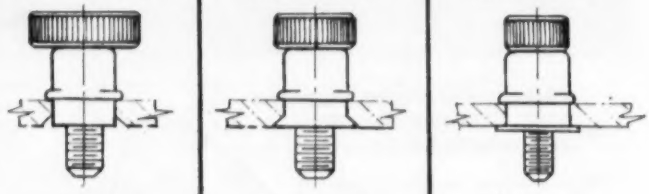
3 SIMPLE COMPONENTS



EASILY INSTALLED

Stand-off is flanged into panel. Screw is inserted into oversize hole in stand-off and locked in place by retaining ring, which is passed over threads to seat behind last thread.

A SIZE FOR EVERY NEED



Screw and stand-off are brass, nickel plated. Retaining ring is durable vinyl plastic.

Choice of stand-offs for each screw size to accommodate panel thicknesses from 1/16" to 7/64".

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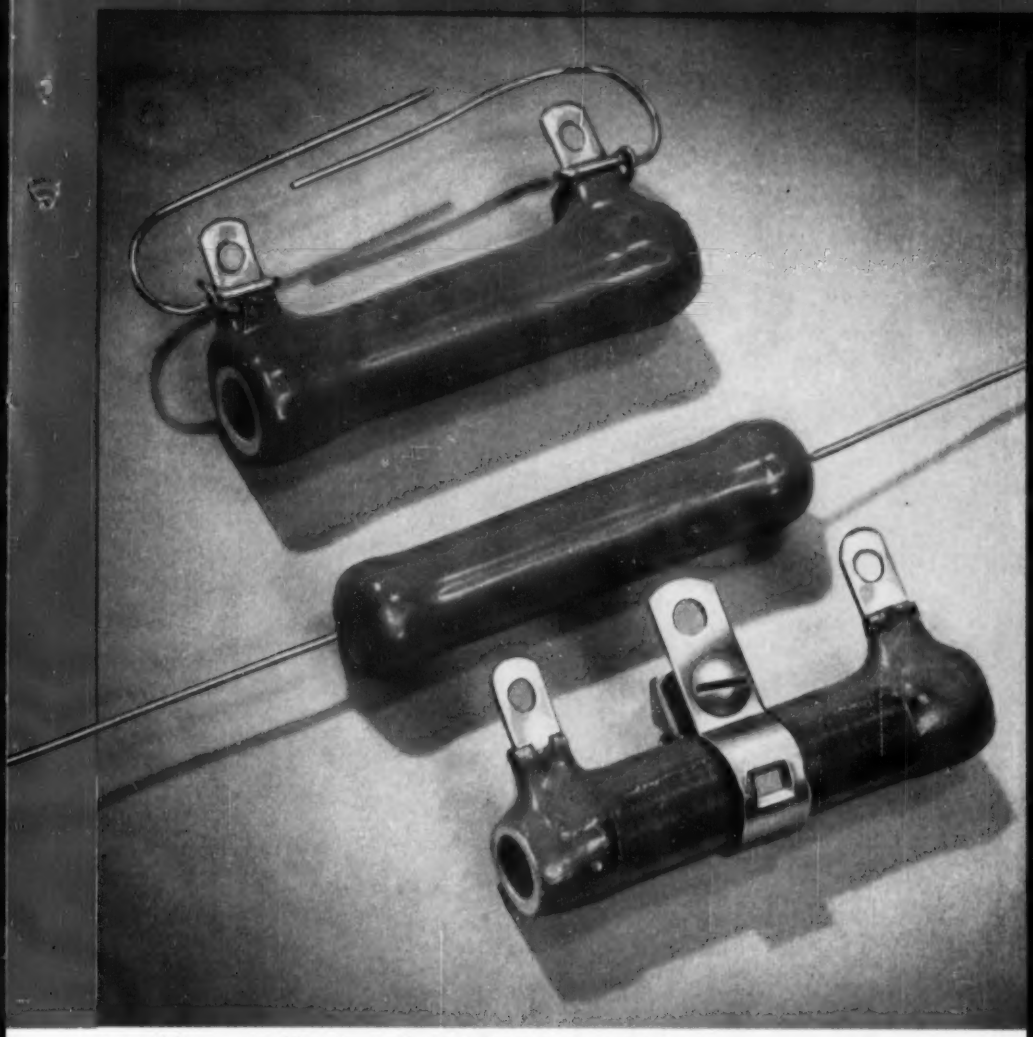

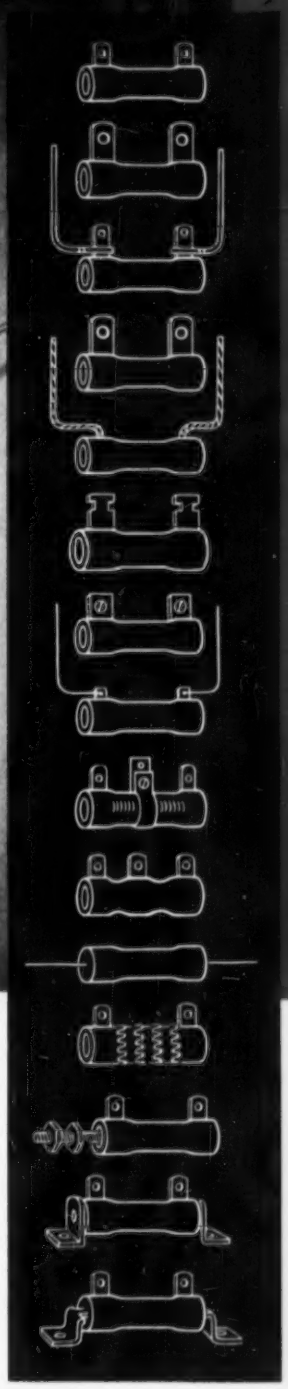

NOTE all diameters and lengths are identical. Photo twice actual size.

How do you want your 10-watt resistors?

Here are a few of the variations you can get in basic design, terminals and mountings on a standard 10-watt Vitrohm resistor.

It's this tremendous variety (we make a wider range of resistors than anybody else) that enables Vitrohm resistors to do so many jobs so well – and save you installation costs at the same time.

Add to this Ward Leonard's performance standards – insured by the 19 separate inspection tests we run on every single resistor we make – and you see why you get more resistor for your money in a Vitrohm.

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Our engineers will be glad to show you which Vitrohm design best meets your specific needs. A line or call to Ward Leonard Electric Company, 450 South Street, Mount Vernon, N.Y. is all it takes.– 5.4

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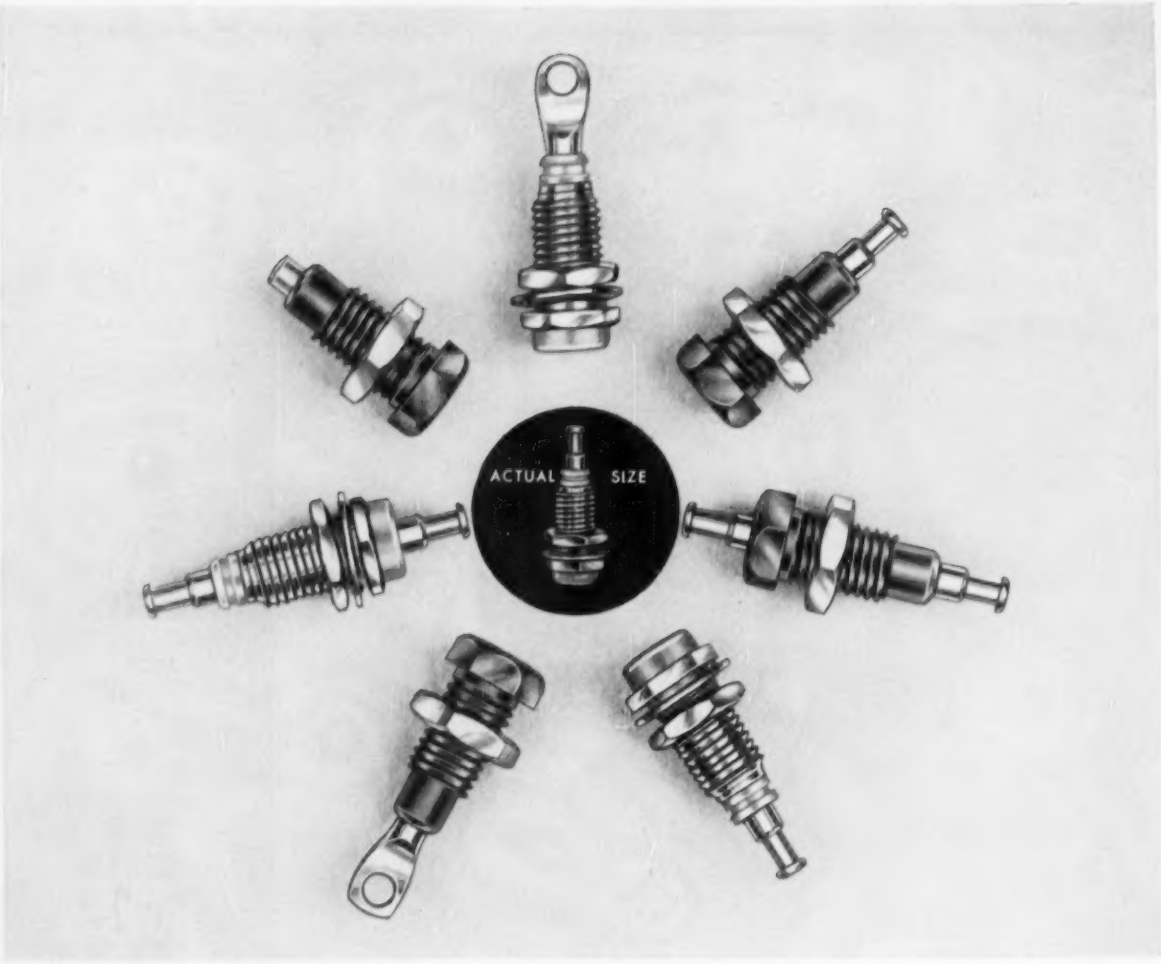

Ucinite Test Jacks

In addition to Test Jacks with a brass, nickel-plated shell and nut with nylon insulator, Ucinite now offers a less expensive version with all-nylon threaded insulator for low capacity to panel and high voltage breakdown.

These Ucinite Test Jacks – designed for standard .080 phone tips – are available in a variety of colors . . . ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements. For full information, call your nearest Ucinite or United-Carr representative or write directly to us.

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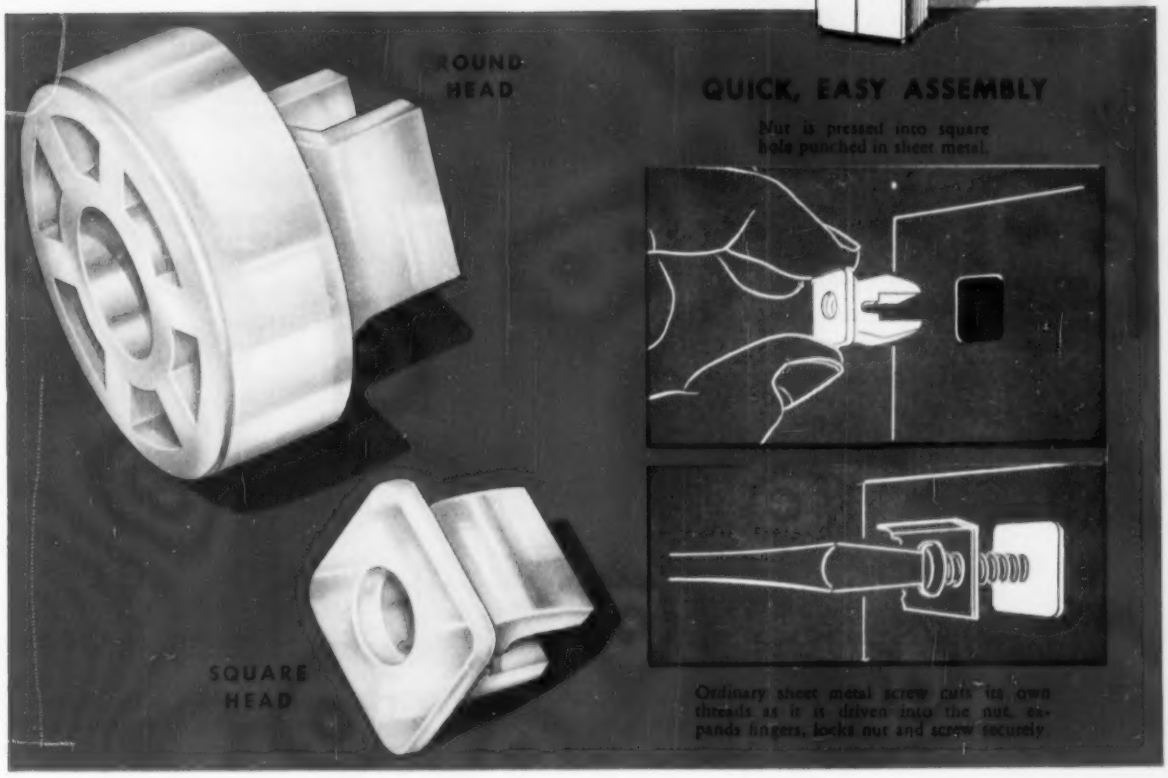
DOT PLASTIC *snap in* NUTS?


ROUND HEAD
SQUARE HEAD
QUICK, EASY ASSEMBLY
Nut is pressed into square hole punched in sheet metal.
Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

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MAKERS OF DOT *FASTENERS*

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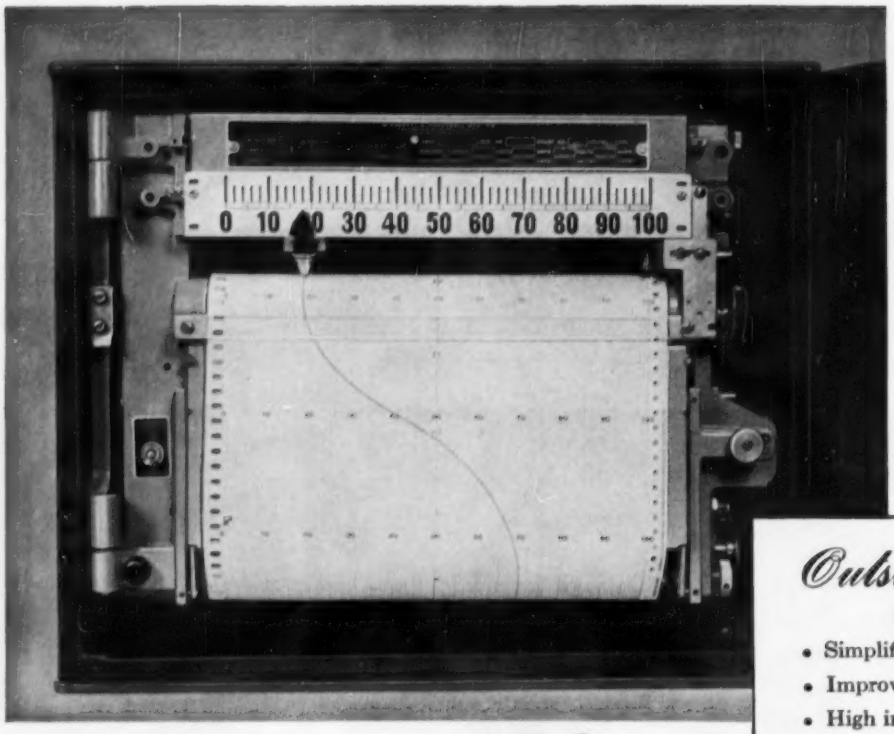

Outstanding
NEW FEATURES

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New 1/4-second *ElectroniK* recorder

follows fast-changing variables with split-second response

Designed to meet the special data-recording requirements of experimental stations, laboratories, and research centers, the new ¼-Second Pen Speed *ElectroniK* Recorder fills an important gap between conventional large-chart recorders and oscillographic instruments.

This new *ElectroniK* Recorder is the *fastest* large-chart instrument available today . . . the perfect solution for high-speed plotting of any function that can be reduced to a d-c millivolt signal. It offers the investigator extreme sensitivity, complete flexibility, laboratory precision . . . plus many *new* features the research man will appreciate:

Easy range change—All components of the potentiometer bridge are located on an interchangeable bakelite card.

New design plug-in amplifier—has many times the power output of standard units . . . features high input impedance, easy accessibility, flexible gain control, and rugged construction.

New pen and carriage designs—prevent pen clogging and paper tearing. Ball point pen easily removed. Transparent cartridge shows ink supply.

New slidewire and contacts—Designed for long life under high speed operation.

Your nearby Honeywell sales engineer will be glad to discuss applications in your research work . . . and he's as near as your phone.

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● **REFERENCE DATA:**
Write for Instrument Data Sheet No. 10.0-21 "¼-Second Pen Speed *ElectroniK* Recorder."

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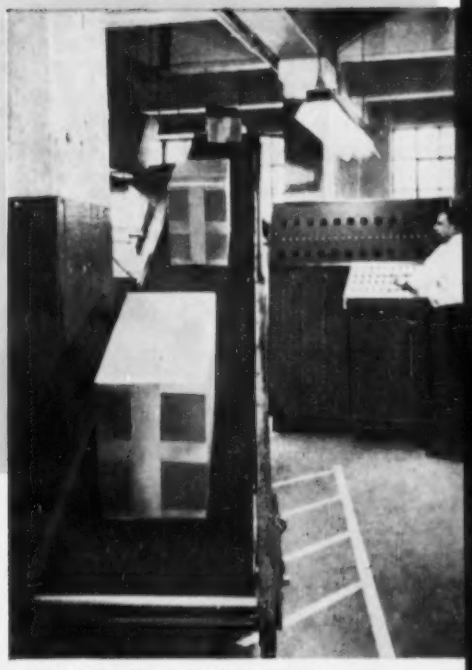
Clare Type A, Fast-operate—fast-release relay . . . for a.c. operation.

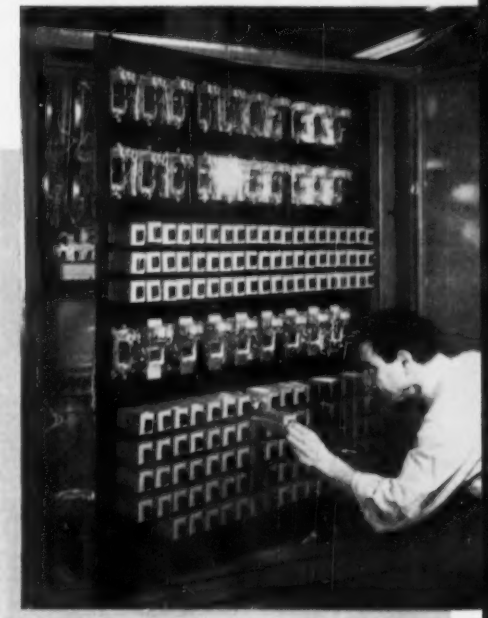
Clare Type D, slow-operate relay . . . for d.c. operation.

Clare Type 26 spring driven stepping switch. Used with 10 levels in DASAC control center.



DASAC Push Button Control Center which uses Clare relays and stepping switches in automatic control of warehouse assorting system.

Rear view of panel shows Clare relays, provided with dust tight covers, accessible for quick inspection and maintenance.



Pushbutton control center of the DASAC warehousing and assorting system makes use of over a hundred CLARE Type A and D relays and CLARE 10 level, 26 point stepping switches.

This device, which speeds and simplifies order picking operations, was developed by New York's Dasol Corporation, consulting engineers, to facilitate the warehouse operations of their client, Judy Bond, Inc., large blouse manufacturer.

The DASAC Control Center performs three basic functions. These include selection of container destination, "memorizing" the selections in consecutive order and coordinating the information to stop the container at its proper discharge point. "Relay requirements," said Sol Tanne, Dasol Chief Engineer, "above all, demanded stability and reliability. They had to be fast-acting, quiet, stable telephone-type relays which could easily be replaced if necessary."

Ability of CLARE Relays to perform millions—in some cases billions—of trouble-free operations has made them increasingly in demand as reliable components for today's high speed devices. If your design calls for long-life, high-quality relays or stepping switches, it will pay you to bring your problem to CLARE. Experienced field engineers are located near you. Contact them or call C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.

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dependable controls

. . . backed by dependable service in matching your specifications and delivery requirements.

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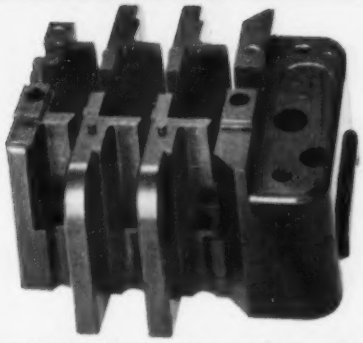
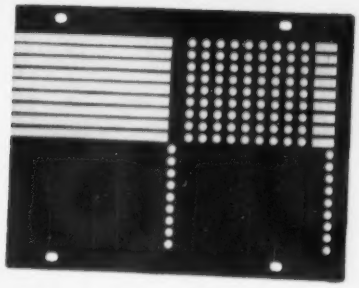
Why the leaders choose **RESINOX* 3700**
for molding profit-making electrical parts

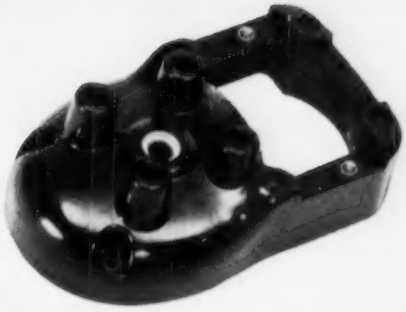


Arrow-Hart & Hegeman are making profitable use of critical electrical parts molded of Resinox 3700 in their combination starter where high arc-resistance is a must.

Wells Manufacturing ignition coil top molded of Resinox 3700 outperformed all others in racing car tests on Utah salt flats. Because of Resinox 3700 no spark power was lost at speeds up to 140 m.p.h.



IBM specifies Resinox 3700 for cross bar emitter —and cuts production costs of this vital "Check Prover" part in half because Resinox 3700 has outstanding dimensional stability.



American Bosch uses this distributor plate molded of Resinox 3700 where its superior arc-resistance is giving top performance in the field. (Part made for them by Specialty Insulation Mfg. Co.)

THE PREFERENCE FOR RESINOX 3700 grows every day. This thermosetting mineral-filled molding powder was developed by Monsanto for superior performance in magneto ignitions, motor control and transmission circuits, and countless other electrical applications. • It combines high arc-resistance with outstanding dimensional stability. • It eliminates undesirable after-shrinkage. • Its moldability is excellent and its impact resistance is good. • It has good transfer molding properties. • It offers superior heat resistance. For full information on Monsanto's Resinox 3700, write today to Monsanto Chemical Company, Plastics Division, Dept. E12, Springfield 2, Massachusetts.

MONSANTO

Serving Industry . . .
which serves mankind

*RESINOX: REG. U. S. PAT. OFF.

For current limiting and for obtaining lagging power factors without distortion —

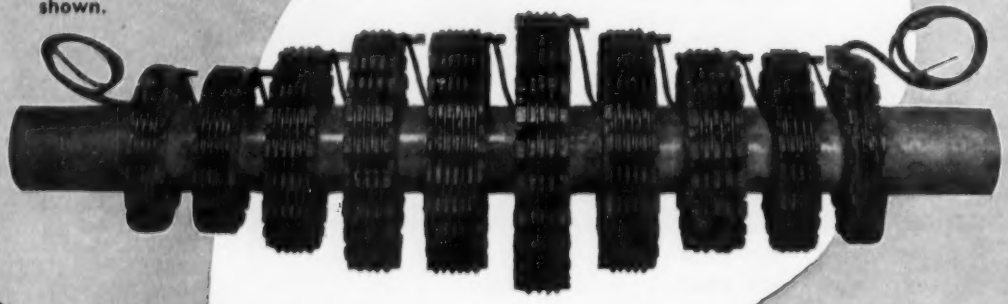
NWL Air Core Reactors

Capacity of ¼ to 2000 Amperes and 25 to 400 cycles.

For lowest possible capacitance and non-resonating peaks —

NWL Radio Frequency (R.F.) Chokes

Available in sizes 1 ampere and larger. In illustration below terminal is not shown.



NWL

ESTABLISHED 1930

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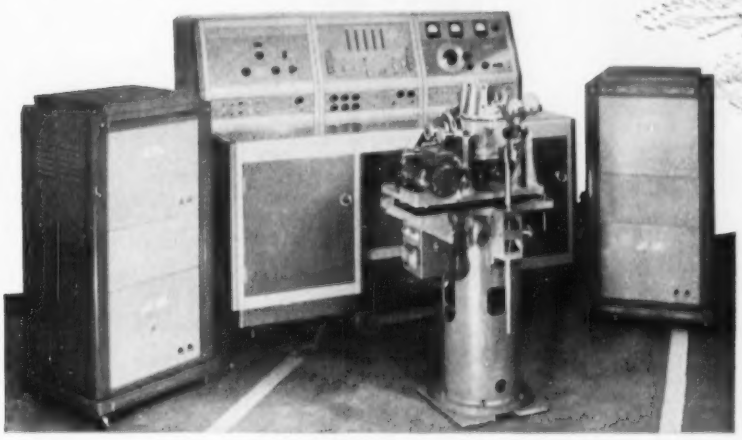
WINDING LABORATORIES, INC.

P. O. Box 455, Dept. 107 TRENTON, N. J.

ANOTHER FIRST BY Greenleaf

Dynamic Integrating Gyro Servo Table



Greenleaf Manufacturing Company, as a producer of Integrating Gyros, realized the need for a Dynamic Integrating Gyro Servo Test Table. This Test Table was designed and developed to facilitate the evaluation of Integrating Gyros, and Greenleaf now makes this valuable test unit available to industry.

The Gyro Servo Test Table can measure the following characteristics:

1. The drift rate of the gyro unit.
2. The current product angular velocity sensitivity ratio.
3. The characteristic time.
4. The angular velocity input voltage rate output sensitivity.
5. Minimum rate detectable.
6. High limit angular velocity deviation of performance.
7. Low limit angular velocity deviation.
8. Signal generator linearity.
9. Torque generator linearity.

Since a time interval meter is incorporated in the system, the following data can also be obtained:

10. Spin motor excitation frequency.
11. Spin motor excitation voltage.
12. Spin motor excitation current.
13. Signal generator excitation current.
14. Signal generator null output voltage.

In addition the following tests can be made:

15. Gyro damping gap temperature.
16. Accurate determination of the input axis.

THE Greenleaf MANUFACTURING COMPANY

ENGINEERING • DEVELOPMENT • PRODUCTION

7814 Maplewood Industrial Court • St. Louis 17, Missouri

Producers of the HIG-3 and HIG-4 Gyros, Rate and Free Gyros, Differential Pressure Mach Meters, Air Speed Indicators, Computers, Switches and many other precision-built components.

49

YEARS AHEAD of the industry...

Type 105 Model 6

New! Northern Radio

FREQUENCY SHIFT KEYER

Sets a new standard for the Industry. It supersedes and directly replaces its LEADER PREDECESSOR, the Type 105 Model 4.

New! Highest Stability achieved by any Frequency Shift Keyer

New! Increased Frequency Range 1.0 to 7.0 mc

New! Pre-selection of Proper Frequency Shift for any particular transmitter frequency multiplication

New! Permits use with external oscillator without need of adapters

New! Improved Accessibility — for even easier maintenance

The new Northern Radio Frequency Shift Keyer Type 105 Model 6, is a very high stability RF oscillator which provides a means for shifting an RF carrier in accordance with the intelligence. This exciter replaces the crystal oscillator in a transmitter and produces "Mark" and "Space" carrier shift for transmission of teleprinter or telegraph signals, or a linear carrier shift for transmission of FM telephone, facsimile or telephoto. In addition to the technical advancements mentioned above, this new Keyer continues to embody the following performance-proven features:

- Direct-reading frequency calibration of shift from 0 to 1000 cps.
- Frequency shift dial adjusts "Mark" and "Space" frequencies equally above and below the carrier position, which remains fixed.
- Simplified frequency setting makes only the upper sideband tuning indication visible on the meter over substantially all of the tuning range.
- Direct-reading frequency calibration of mixer and output tuning dials from 1.0 to 7.0 mc.
- Direct-reading calibration of output frequency vernier ± 600 cps.
- Pulse-shaping circuit to permit operation within assigned bandwidth with no adjacent channel radiation.
- Highly stable temperature-controlled oven with control of ± 0.1°C. at 60°
- Linear carrier shift up to 1400 cps for Fax operations.
- Component ratings according to JAN specs for greater assurance of trouble-free operation.

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.

147 WEST 22nd ST., NEW YORK 11, NEW YORK

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

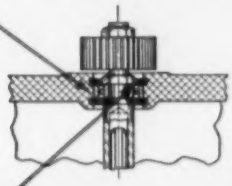
Write for Free Catalog E-12.

4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

Dumore's New Automatic Drill

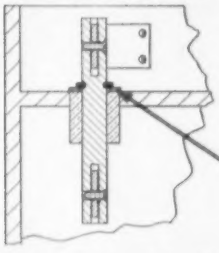
Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

Drive Spindle Assembly



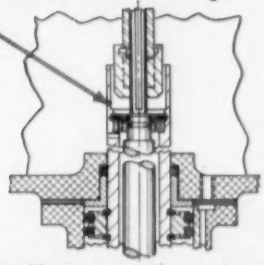
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

Piston Assembly



Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name .....
Title .....
Company .....
Business Address .....
City ..... *Zone* ..... *State* .....

E 127

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

LIQUID COOLING

of Electronic Tubes

WITH Eastern

COOLING UNITS

By a sustained program of research, Eastern continuously extends the uses of the latest units in electronic tube cooling, pressurizing electronic equipment, and pumping fuels and hydraulic fluids. Research and testing laboratories, a model shop, and three manufacturing plants provide the specialized equipment and manpower to turn out fully qualified units to meet appropriate government specifications.

From our extensive line of existing units, adaptations of these units, or completely new designs, Eastern can provide equipment to handle your project well. Your inquiry is welcomed.

EASTERN INDUSTRIES, INC.
100 SKIFF STREET
HAMDEN 14, CONNECTICUT

Eastern Cooling Units provide coolant liquid for maintaining within safe operating temperature limits liquid cooled electronic tubes or similar devices. The units are completely self-contained and usually comprise such components as heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, etc.

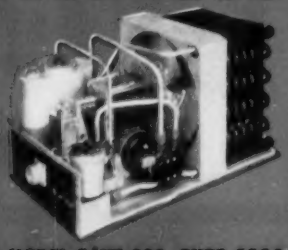
Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

The units shown below are intended only to illustrate the varying requirements which can be satisfied. By utilizing fairly standard components and designs based on broad experience in this field, Eastern is able to provide at minimum cost equipment exactly suiting a specific requirement.

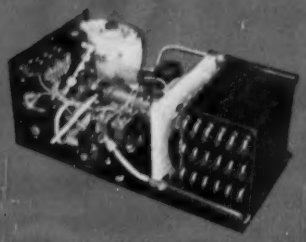
Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.

Write for Aviation Products Bulletin 330.

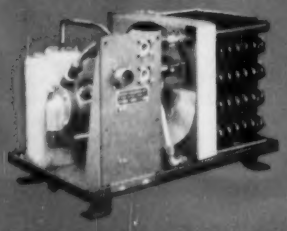
MODEL MB-175, TYPE 200 DISSIPATION: 2,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 15-13/16" x 10¾" high.



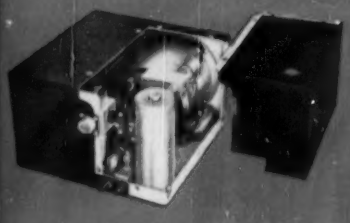
MODEL E/MT-285, TYPE 200A DISSIPATION: 1600 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 25 pounds. SIZE: 10" x 21" x 10" high.



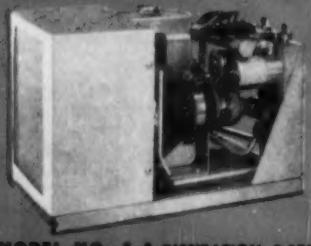
MODEL MB-177, TYPE 202 DISSIPATION: 1700 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 110 volt, 400 cycle, 3 phase. WEIGHT: 27 pounds. SIZE: 10" x 19 15/32" x 7⅝" high, per JAN-C-1720A, size 81-D1.



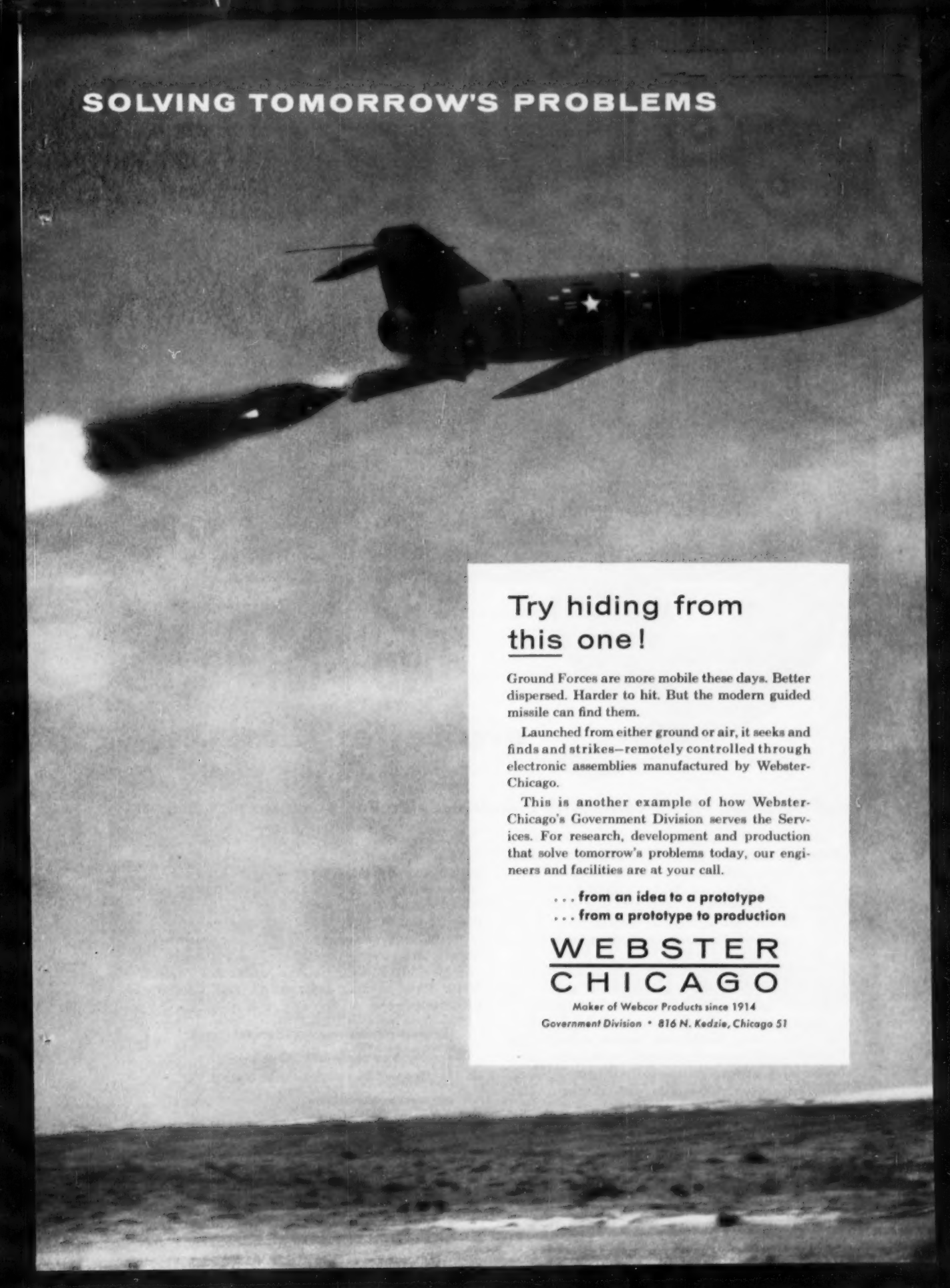
MODEL E/MT-210, TYPE 200 DISSIPATION: 1500 watts. ALTITUDE RANGE: sea level to 10,000 feet. POWER REQUIRED: 208 volts, 400 cycle, 3 phase. WEIGHT: 35 pounds. SIZE: 11¼" x 19½" x 12½" high.



MODEL E/MT-209, TYPE 201 DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 50,000 feet. POWER REQUIRED: 28 volts D.C. WEIGHT: 14½ pounds. SIZE: 10" x 19" x 6" high.



MODEL NO. 5-A DISSIPATION: 1,000 watts. ALTITUDE RANGE: sea level to 5,000 feet. POWER REQUIRED: 100 to 110 volts D.C. WEIGHT: 10 pounds. SIZE: 7⅞" x 13½" x 9-1/16" high.



Try hiding from this one!

Ground Forces are more mobile these days. Better dispersed. Harder to hit. But the modern guided missile can find them.

Launched from either ground or air, it seeks and finds and strikes—remotely controlled through electronic assemblies manufactured by Webster-Chicago.

This is another example of how Webster-Chicago's Government Division serves the Services. For research, development and production that solve tomorrow's problems today, our engineers and facilities are at your call.

. . . from an idea to a prototype
. . . from a prototype to production

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Two Metals
are Better Than One

...and GENERAL PLATE Composite Metals Provide Performance plus Economy

Virgin metals and alloys have their limitations, and to overcome them . . . to get the *exact* performance you want . . . General Plate Composite Metals are the answer. They give you broadened physical and metallurgical characteristics . . . meet your specific requirements closer and do the job better, at lower costs.

For instance — permanently bonded copper to steel gives both high conductivity and extra rigidity. Silver or gold bonded to copper or bronze combines workability with high corrosion resistance. Bronze on copper makes ideal current carrying spring material with higher conductivity. Ferrous and non-ferrous combinations give you composite metals with magnetic and non-magnetic surfaces.

General Plate Composite metals in dozens of combinations eliminate many headaches . . . are the answer to corrosion, conductivity, heat dissipation, cost and many other problems.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling, composite contacts, buttons and rivets, *Truflex*® Thermostat Metals, *Alcuplate*®, platinum fabrication and refining, #720 Manganese Age-hardenable Alloy. Write for complete information and Catalog PR-700 today.

You can profit by using General Plate Composite Metals!

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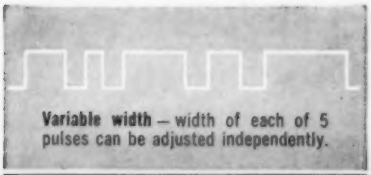
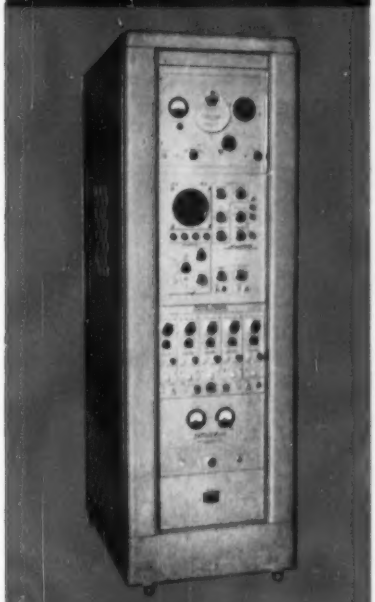
GENERAL PLATE DIVISION
312 FOREST STREET, ATTLEBORO, MASS.

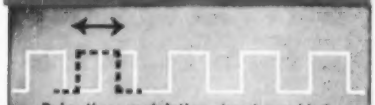


Variable width—width of each of 5 pulses can be adjusted independently.

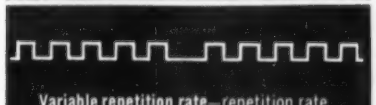
Variable delay—delay between each of 5 pulses can be adjusted independently.



CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR Model B



Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.



Variable repetition rate—repetition rate of each group of pulses can be varied.

CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

Model B 950-10,750 mc

Generates multi-pulse modulated carrier for beacons, missiles, radar... provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies ...all in one integrated mobile instrument.

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

A fully integrated self-contained equipment with these features:

Four Interchangeable Microwave Oscillator Units—all stored in the instrument... each with UNI-DIAL control... precision power monitor circuit to maintain 1 mw power output reference level... keying circuit to assure rapid rise time of modulated r-f output... non-contacting chokes.

Five Independently Adjustable Pulse Channels—each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

Precision Oscilloscope with Built-In Wide Band RF Detector for viewing the modulation envelope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

Self-Contained Power Supplies—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

SPECIFICATIONS:

Frequency Range:
- Band 1 . . . 950 to 2400 mc
- Band 2 . . . 2150 to 4600 mc
- Band 3 . . . 4450 to 8000 mc
- Band 4 . . . 7850 to 10,750 mc

Frequency Accuracy . . . ±1%
RF Power Output . . . 1 milliwatt maximum (0 DBM)
Attenuator:
- Output Range . . . 0 to −127 DBM
- Output Accuracy . . . ±2db
- Output Impedance . . . 50 ohms nominal

RF Pulse Characteristics:
- a. Rise Time . . . Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time . . . Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot . . . Less than 10% of maximum amplitude of the initial rise.

Internal Pulse Modulation:
- No. of Channels . . . 1 to 5 independently on or off
- Repetition Rate . . . 40 to 4000 pps
- Pulse Width . . . 0.2 to 2.0 microseconds
- Pulse Delay . . . .0 to 30 microseconds
- Accuracy of Pulse Setting . . . 0.1 microsecond
- Minimum Pulse Separation . . . 0.3 microsecond
- Initial Channel Delay . . . 2 microseconds from sync. pulse
- Internal Square Wave . . . 40-4000 pps (separate output)

Pulse Time Modulation:
- Frequency . . . 40-400 cps any or all channels
- Required Ext. Mod. . . . 1 volt rms min.
- Maximum deviation . . . ±0.5 microsecond

Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

POLARAD ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

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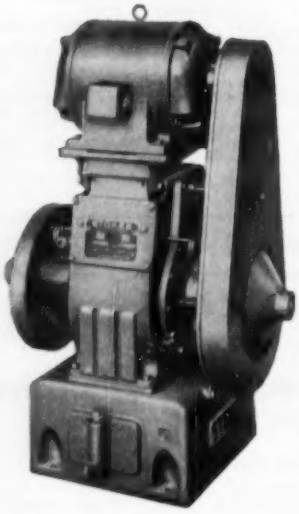
RCA ALUMINIZES TV TUBES ON

Overall view of Stokes continuous vacuum metallizing dolly system for aluminizing TV tubes at RCA's Marion, Indiana plant. Operator is required only to load and unload tubes from the 22 carts.

THE COMPLETE LINE OF STOKES

Stokes manufactures a complete line of vacuum pumping equipment. This includes mechanical vacuum pumps, diffusion and booster pumps, vacuum valves and gages, and complete vacuum instrumentation. In engineered high vacuum equipment, Stokes builds vacuum metallizers, vacuum furnaces and other vacuum processing equipment.

Stokes has for many years been active in vacuum research. Vacuum experience among our engineers covers the range from laboratory equipment to some of the largest vacuum equipment in service. This experience is available to help solve your vacuum problems.



STOKES MECHANICAL VACUUM PUMPS

For vacuum processing systems and for maintaining low forepressures in high-vacuum systems, the Stokes Microvac pump provides efficient, economical operation. Designed with fully automatic lubrication and a long-lasting exhaust valve assembly, every Microvac pump is assured of smooth, trouble-free operation. Six sizes give capacities from 15 to 500 cfm. Gas-ballast available on all sizes. Send for catalog listed.

STOKES METALLIZING DOLLIES

The new Stokes installation at RCA's Marion, Indiana, plant is a valveless, rugged system capable of aluminizing up to 120 TV picture tubes per hour. Low in operating cost, it is by far the least complex continuous aluminizing system available. It is designed without timers, gadgets or intricate accessories, any of which could fail and stall production. The system is so free of vibration that a five-cent piece can be balanced on the dollies while they are in motion.

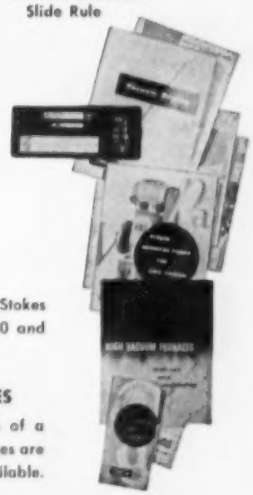
Operation is simplicity itself: the operator loads one tube to a cart; pressure is automatically reduced to the required vacuum, the filament is automatically flashed and the completed metallized tube delivered to the operator's station.

For metallizing COLOR or BLACK AND WHITE TV tubes, Stokes designs and installs automatic or semi-automatic in-line systems or stationary units, in standard designs or to customer's requirements.

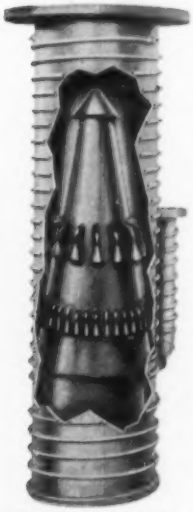
F. J. STOKES MACHINE COMPANY
PHILADELPHIA 20, PA.

SEND FOR TECHNICAL LITERATURE:

- Microvac Pumps—Catalog 750
- Diffusion and Booster Pump Specification sheets and performance curves
- The Story of the Ring-Jet Pump
- Complete Vacuum Processing Systems—Catalog 730
- How to Care for Your Vacuum Pump—Booklet 755
- Vacuum Impregnation—Catalog 760
- Vacuum Drying—Catalog 720
- Vacuum Furnaces—Catalog 790
- Vacuum Metallizing—Catalog 780
- Vacuum Calculator Slide Rule



VACUUM EQUIPMENT



STOKES RING-JET DIFFUSION AND BOOSTER PUMPS

The new Stokes Ring-Jet Pumps embody a new concept of the diffusion principle. Size for size, they have pumping speeds of 10% to more than 100% above any other diffusion pump for a given heat input. Ring-Jet Diffusion Pumps are available in sizes of 4, 6, 10, 14 and 16 inches; Booster Pumps in sizes of 4, 6, 10 and 16 inches. Send for information listed.

STOKES VACUUM VALVES

To control vacuum safely and surely, Stokes vacuum valves are available in 4, 6, 10 and 16-inch standard flange sizes.

STOKES-McLEOD VACUUM GAGES

For measuring vacuums from fractions of a micron up to 50 mm, Stokes-McLeod gages are the standard of reference. Four sizes available.

STOKES

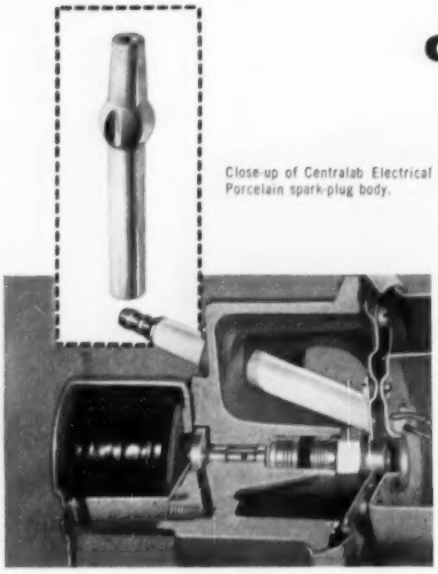
ENGINEERS: Stokes is continually adding to its engineering and technical sales staffs in the high vacuum, industrial tabletting, powder metal and plastics molding fields. If you can qualify, there may be a position for you.

OFFICES IN PRINCIPAL CITIES, REPRESENTATIVES THROUGHOUT THE WORLD

To withstand high heat, shock, and continuous off-on cycling . . .

Centralab ceramic insulator

used as igniter in new, instant car heater



Close-up of Centralab Electrical Porcelain spark-plug body.

Cutaway view of the heat exchanger and burner assembly. Centralab Electrical Porcelain spark plug is in upper left-hand corner. Fuel is ejected through metal nozzle just below spark plug.

A newly designed, gasoline-burning, instant heater for passenger automobiles uses the principle of reliable aircraft heaters.

The new heater is an injection-type system which is complete in itself. Ignition is accomplished by a spark plug of Centralab Electrical Porcelain, energized by a separate ignition system.

The spark is cycled off and on with the fuel — usually several times per minute, as the off-on cycling modulates heater output. Ignition is instantaneous.

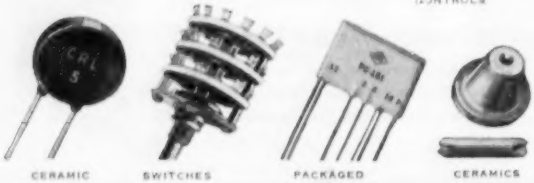
This calls for complete reliability and perfect timing — accomplished with Centralab Electrical Porcelain made for specific heat-range and heat-shock requirements. Like all Centralab ceramics, it has high heat resistance, high dielectric strength, and dimensional stability.

Get the whole story on *all* the Centralab ceramics — including Steatite, Cordierite, Zirconite, and Titanate. Write for Centralab Ceramic Buyer's Guide, Bulletin 42-221. Or refer to it in Sweet's Product Design File.

More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry

CONTROLS



CERAMIC CAPACITORS | SWITCHES | PACKAGED ELECTRONIC CIRCUITS | CERAMICS

SPECIAL this month only!

Centralab Sweepstakes

28 Big Prizes!

Nothing to buy!
Nothing to answer!

1st PRIZE — $100.00 Gift Certificate for a Hart-Schaffner & Marx Suit.

2nd PRIZE — Four (4) Arrow Shirts.

3rd PRIZE — Two (2) Arrow Shirts.

Twenty-five (25) 4th PRIZES — One (1) Arrow Tie each.

To be eligible for the grand drawing, simply send us your name and address on your letterhead. Or ask your Centralab rep for an entry blank. Entries must be postmarked no later than midnight, December 31, 1955. Contest not open in states where prohibited.

X-5513

Centralab

A DIVISION OF GLOBE-UNION INC.

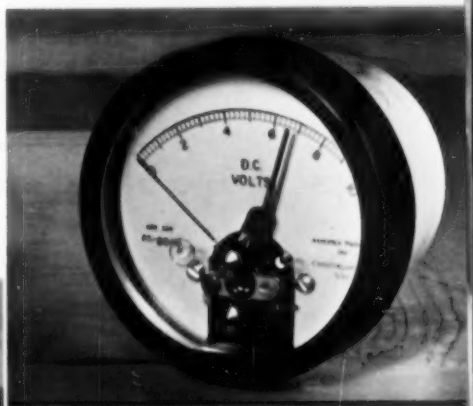
914L E. Keefe Avenue • Milwaukee 1, Wisconsin
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

new product information

December, 1955
MP-2

RUGGEDIZED-SEALED METER-RELAYS



MODEL 255-C 1½ Inch — Narrow bezel provides same dial area as usual 3½ inch meter. MIL M-6A Mounting Dimensions

These ruggedized versions have the same electrical specifications and use the circuitry shown in Bulletin G-6.

Meter-relays are indicating meters with built-in relay contacts. One contact is carried on the moving pointer. The other is carried on a semi-fixed pointer. When the two pointers meet, the contacts close and lock. Locking coil is wound directly over moving coil. Reset can be manual or automatic. It consists of opening the locking circuit. Spring action in contacts kicks them apart forcefully. There are no pushers nor solenoids inside meter case.

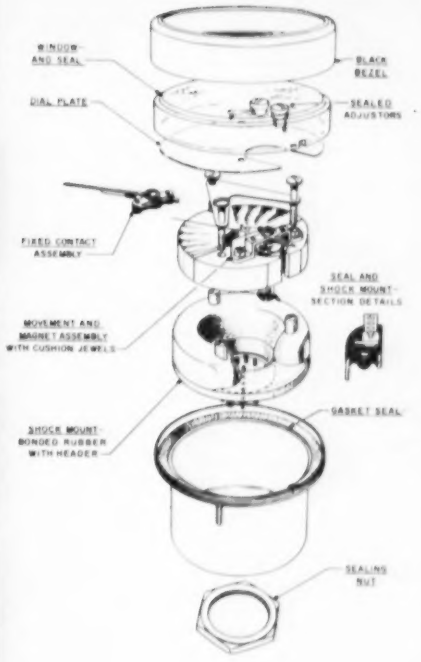
These instruments meet the mounting dimension requirements of MIL M-6A. The degree of resistance to shock and vibration depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. The most sensitive relays may close their contacts under these conditions.

Usual meter ranges can be supplied from 0-20 Ua. to 0-50 A., or, 0-5 Mv. to 0-500 V. All ranges can be supplied either AC or DC except low millivolts (under 0-250 Mv.). These come only in DC because of limitations of instrument rectifiers. Higher voltage or current ranges are made with external multipliers.

Contact setting is adjustable from front to any point on scale arc. Or, it may be preset at any fixed point. Contact arrangements are (1) single high (2) single low (3) double, high and low. When used only as relays they can be made to operate on as little as 0.2 microamperes (3000 ohms) or 0.05 millivolts (20 ohms).

All models can be supplied as contact meters, illustrated in the upper photos, or as a panel meter, shown below.

Black Face
MODEL 355-C 3½ INCH
White Face



MODEL 455, 4½ INCH

The DEW Line:

The Model 255-C meter-relays perform a vital function in DEW Line (Distant Early Warning Radar Screen) equipment manufactured by Raytheon Manufacturing Company, Waltham, Mass., where they meet these specifications:

ELECTRICAL:	0/100 microamperes with specified speed and damping.
SHOCK:	1 and 3-foot drops, 400 lb. hammer, 3 planes.
VIBRATION:	MIL-M-10304 (Sig C)
SALT SPRAY:	QQ-M-151 A
TEMPERATURE:	-30° C to +70° C
SEALING:	MIL-M-6A

CHESTERFIELD CIGARETTES:

Cigarette quality is controlled by the AccuRay Cigarette Gauge-Controller made by Industrial Nucleonics Corporation, Columbus, Ohio. It has appeared in Chesterfield ads in newspapers and magazines, and on the Dragnet, Gunsmoke, and Warner Brothers Presents television shows. The Model 355-C double contact meter-relay is a basic component of this automatic process control.

ASSEMBLY PRODUCTS, INC.

Wilson Mills Road
Chesterland 4, Ohio
Telephone (Cleveland, Ohio)
HAmilton 3-4436

Or

69-873 Dillon Road
P. O. Box 308
Desert Hot Springs 1, California
Telephone 4-2468

RUGGEDIZED-SEALED METER-RELAYS

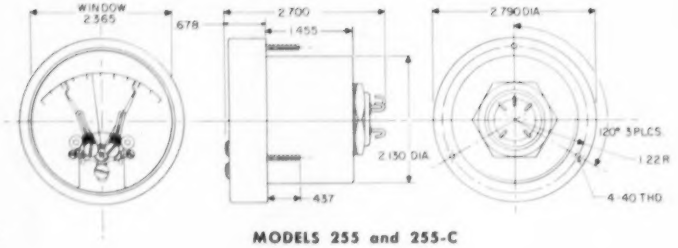
DATA SHEET

Ordering Specifications

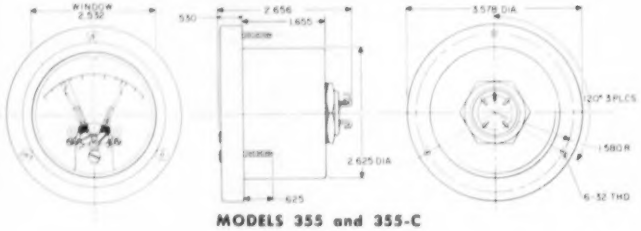
CONTACTS: The same size contacts (platinum-iridium) are used for all contact ratings. Locking coil turns vary for different ratings. Standard rating 5 - 25 DC milliamperes, 75 - 125 volts. Other ratings to 100 Ma.

- ☐ HIGH LIMIT CONTACTS: Standard.
- ☐ LOW LIMIT: Same price, specify "Low Limit".
- ☐ DOUBLE CONTACT: Add $10.00.
- ☐ FIXED CONTACT: Single ☐ deduct $2.00. Double ☐ deduct $3.00.
- ☐ ISOLATED COILS: (Maximum insulation 50 volts) add $5.00.
- ☐ DOUBLE LOCKING COIL: (for same contact polarity on both high and low limits) add $5.00.
- ☐ SUPPRESSED ZERO: (scale 40-80 etc.) add 10%. (Specify range).
- ☐ AC METER-RELAYS: (rectifier type) add $5.00 and specify AC (minimum volts range 0/250 AC millivolts).
- ☐ SPECIAL CONTACT RATING: _____ DC volts, _____ DC milliamperes.
- ☐ MOUNTING: Will be mounted in steel ☐ or non-magnetic material ☐

RANGE: _____



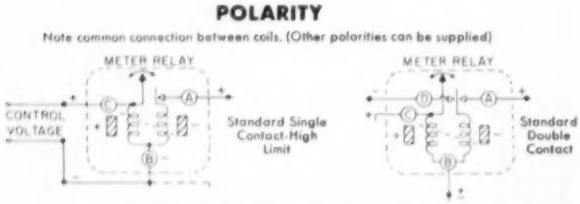
MODELS 255 and 255-C

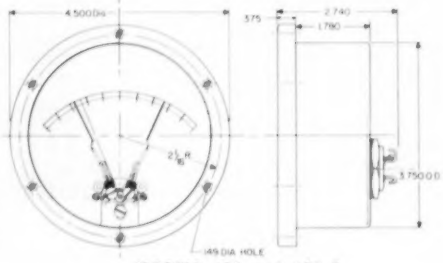


MODELS 355 and 355-C

POLARITY

Note common connection between coils. (Other polarities can be supplied)





MODELS 455 and 455-C

RUGGEDIZED-SEALED METER-RELAY PRICES

		Model 255-C 2½ Inch	Model 355-C 3½ Inch	Model 455-C 4½ Inch
DC Microamperes	**Ohms**			
0— 20	3,000	$63.25	$68.25	$73.25
0— 50	3,000	51.00	56.00	61.00
0—100	950	46.00	51.00	56.00
0—250	650	43.00	46.00	51.00
0—500	100	41.00	45.50	49.00
(Intermediate and higher ranges priced same as nearest listed)				
DC Milliamperes				
0—1 to 0—50 (Approx. 100 Mv.)		$40.00	$44.50	$48.00
0—55 to 0—1000 (Approx. 50 Mv.)		45.00	49.00	53.00
DC Amperes				
0—1 to 0—50 (Approx. 50 Mv.)		45.00	49.00	53.00
(External shunt required for ranges over 50 Amperes)				
DC Millivolts	**Ohms**			
0— 5	20	$63.25	$69.00	$75.00
0—10	40	51.00	56.00	61.00
0—25	100	45.00	50.00	55.00
0—50	50*	41.00	46.00	51.00
*(Supplied as standard. 5 ohms, 200 ohms, and other resistances available.)				
(Intermediate and higher ranges priced same as nearest listed)				
DC Volts				
0—1 to 0—500 (Approx. 1000 ohms per Volt. Other sensitivities available.)		$42.50	$47.00	$50.50
(External resistor required for ranges over 500 volts)				

QUANTITY DISCOUNTS

Meter-Relays and Contact Pyrometers

Quantity	Discount
1—4	Net
5—24	15%
25—49	20%
50—99	22½%
100—199	25%

200 up request quotation.

For one range of one model only.

CONTACT PYROMETER PRICES (4 ohms/millivolt with bimetal compensation)

		Int. Res.	Ext. Res.	Thermo-couple	Model 255-C 2½ Inch	Model 355-C 3½ Inch	Model 455-C 4½ Inch
0—3000°F	0—1650°C	70	10	Pt 13% Rh	$46.00	$51.00	$56.00
0—2500	0—1370	212	10	C/A	41.00	46.00	51.00
0—2000	0—1100	172	10	C/A	41.00	46.00	51.00
0—1500	0— 800	179	10	I/C	41.00	46.00	51.00
0—1000	0— 500	112	10	I/C	44.00	49.00	54.00
0— 750	0— 400	81	10	I/C	46.00	51.00	56.00
0— 500	0— 260	52	10	I/C	49.00	54.00	59.00
0— 300	0— 150	22	10	I/C	54.00	59.00	64.00
−75 to +225	−60 to +110	22	10	I/C	54.00	59.00	64.00
−200 to +100	−130 to + 40	22	10	C/C	59.00	64.00	69.00

Thermocouples shown are standard. Pyrometers can be calibrated for use with most other types at extra charge. Ranges listed are standard. Special ranges made to order.

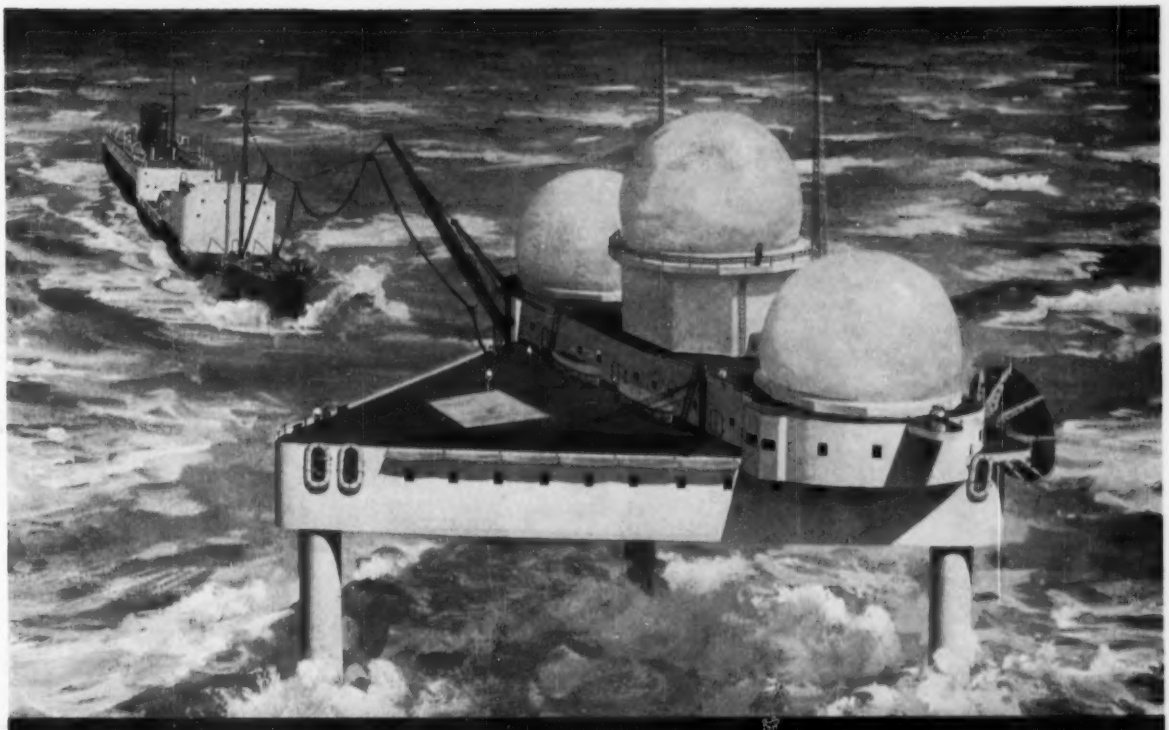
ASSEMBLY PRODUCTS, INC.

Wilson Mills Road
Chesterland 4, Ohio
Telephone (Cleveland, Ohio)
HAmilton 3-4436

Or

69-873 Dillon Road
P. O. Box 308
Desert Hot Springs 1, California
Telephone 4-2468

Litho in U. S. A.



EIMAC KLYSTRONS are used in Texas Towers forward-scatter communications system

High power UHF/microwave forward-scatter transmitters by National Company are an example of reliable National equipment designed to meet the most exacting requirements. From the first National Company forward-scatter development link to the advanced Texas Tower communication net, Eimac klystrons have been used exclusively as high power final amplifier tubes. Eimac amplifier klystrons provide the power necessary to make long distance communication through forward-scatter techniques practical at microwave frequencies.

- ***Second in a series of advertisements emphasizing the extensive application of Eimac amplifier klystrons and circuit components by the leading manufacturers of forward-scatter UHF/microwave transmitters.***

National Company two, ten and fifty kilowatt transmitters employing Eimac klystrons and circuit components are among the pacesetters in the revolutionary art of forward-scatter propagation.

Eimac
THE POWER FOR FORWARD-SCATTER

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

vacuum-melted components give long, reliable performance . . .

Vacuum-melted metals are the answer to the engineer's search for more *reliable* materials. In vacuum tube components, for example, these superior metals mean longer tube life . . . *stable* electrical characteristics even after repeated heatings. For vacuum-melting *removes* undesirable gases *before* they are put in the tube.

Vacuum-melting literally sucks gaseous impurities and inclusions from the molten metal. You get high-purity, gas-free metals that far outperform conventional air-melted metals. Cathode nickel alloys, iron, and alloys for metal-glass seals are held to *uniformly* close standards of composition. Purity and soundness of *any* metal is improved.

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted and cast metals, has available a wide range of these unique metals designed for electrical and electronic uses. If you believe they might improve your product, please write, giving full details. Our engineers will give them careful attention. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

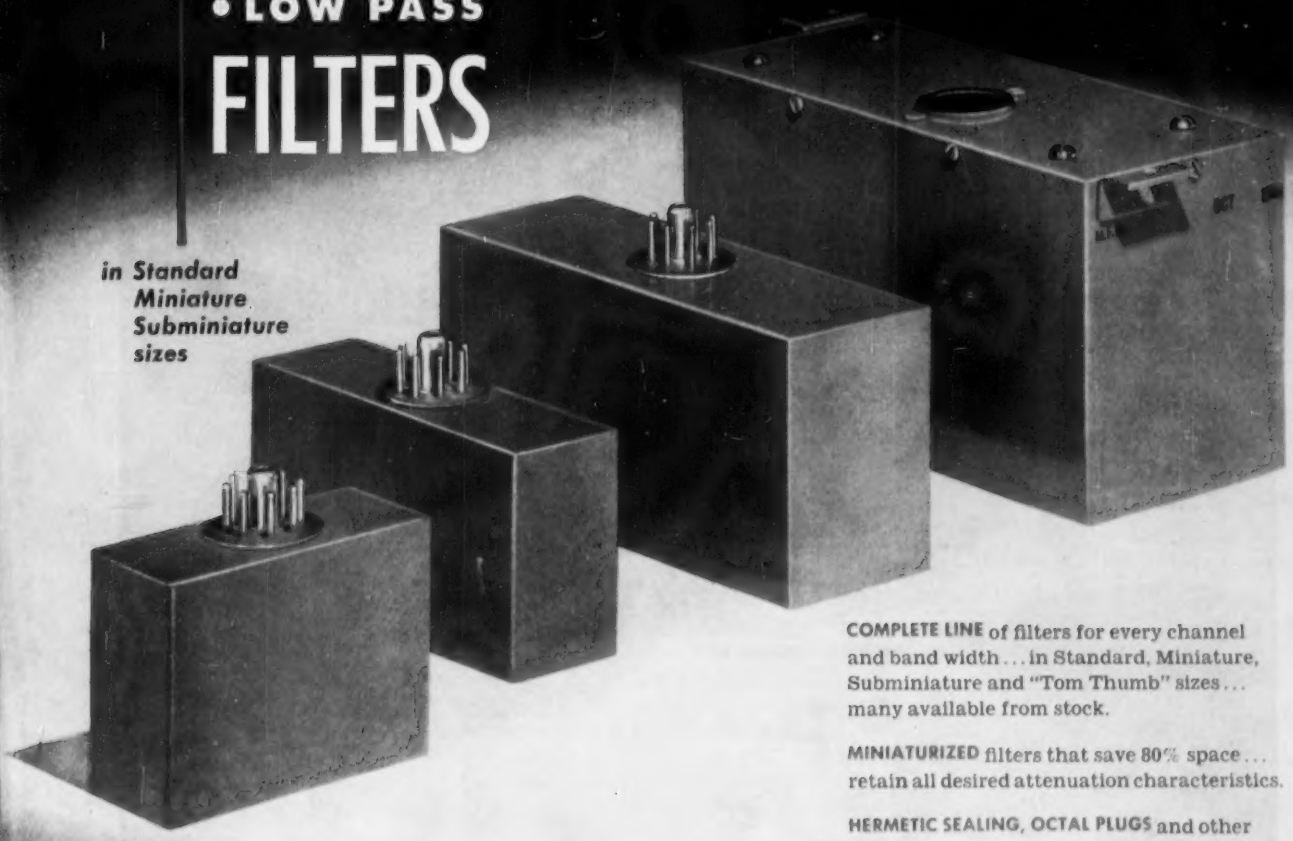
VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

TELEMETERING

• BAND PASS
• LOW PASS
FILTERS

in Standard
Miniature
Subminiature
sizes



COMPLETE LINE of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

MINIATURIZED filters that save 80% space . . . retain all desired attenuation characteristics.

HERMETIC SEALING, OCTAL PLUGS and other new features.

only Burnell offers you . . .

SPECIAL PHASE LINEARITY characteristics to conform to new concepts of high accuracy telemetering practice.

SPECIFICALLY DESIGNED for telemetering, these filters have found great utility in a wide variety of communications and control applications.

APPLICATION ENGINEERING service plus complete technical literature. Write Dept. C-12 for Catalog 102A.

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

Channel Freq.	15% Band Width	30% Band Width	Case Size	Approx. Weight	Attenuation	
	Type No.	Type No.	W- L- H-		15% B. W.	30% B. W.
400 CPS.	S-15456					
560 "	S-15457	S-15477	2 x 6 x 2⅜	3 lbs.	4DB — 15%	4DB — 30%
730 "	S-15458	S-15478			20DB — 23%	20DB — 46%
960 "	S-15459				40DB — 27%	40DB — 54%
1300 "	S-15460				3.5DB — 15%	3.5DB — 30%
1700 "	S-15461		1⅞ x 4½ x 2¼	1 lb. 7 oz	20DB — 23%	20DB — 46%
2300 "	S-15462				40DB — 27%	40DB — 54%
2570 "	S-15463					
3000 "	S-15464					
3900 "	S-15465	S-15479				
4500 "	S-15466					
5400 "	S-15467	S-15480				
7350 "	S-15468	S-15481				
10500 "	S-15469	S-15482			3DB — 15%	3DB — 30%
12300 "	S-15470	S-	1⅜ x 3 x 2¼	9¾ oz.	20DB — 23%	20DB — 46%
14500 "	S-15471	S-15483			40DB — 26%	40DB — 52%
22000 "	S-15472	S-15484				
27000 "		S-15485				
30000 "	S-15473	S-15486				
40000 "	S-15474	S-15487				
52500 "	S-15475					
70000 "	S-15476	S-15488				

OPTIMUM OPERATING IMPEDANCES — SOCKET TERMINAL CONNECTIONS

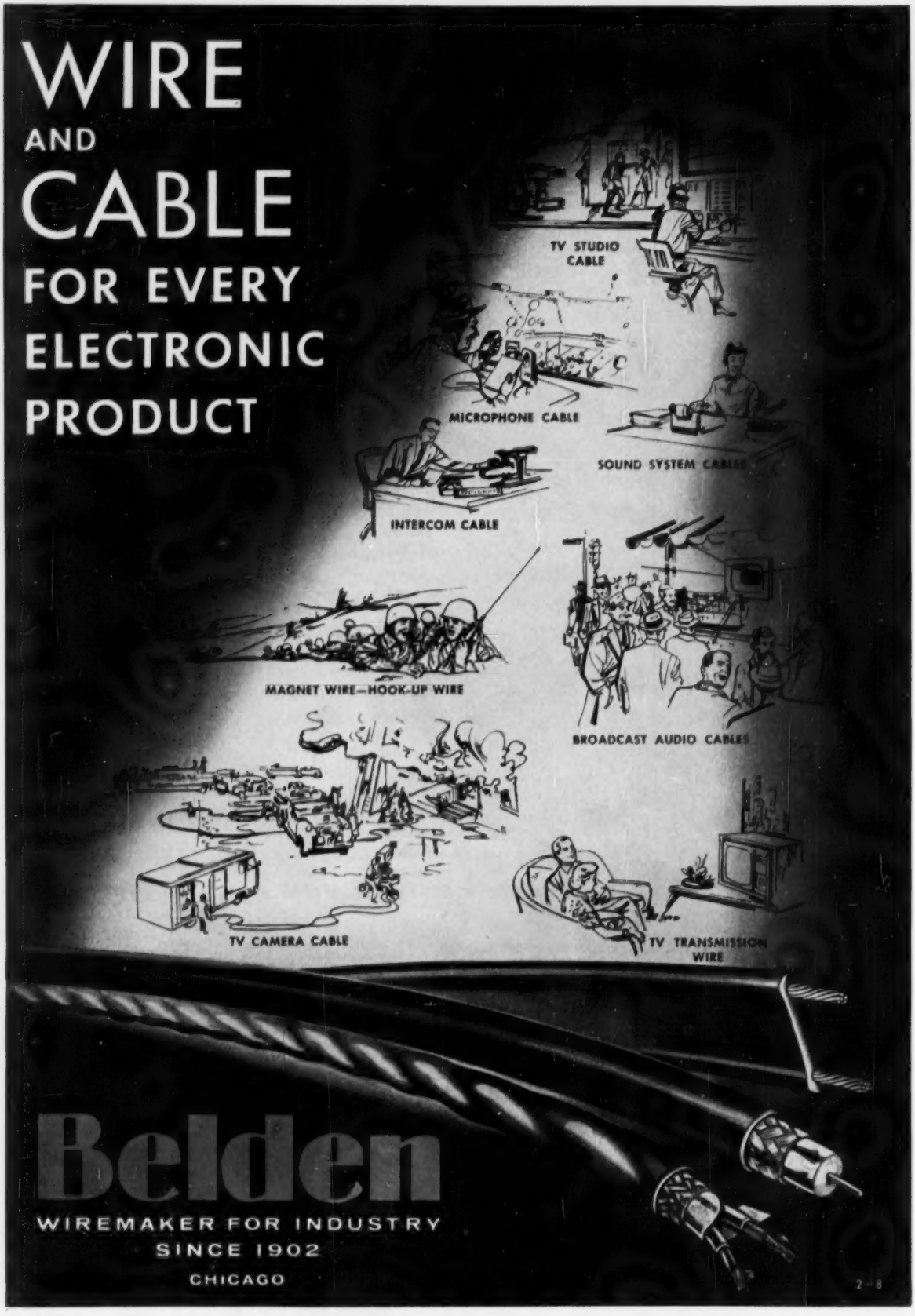
INPUT		OUTPUT	
Terminals 1 & 2	500 ohms	Terminals 1 & 6	500 ohms
Terminals 1 & 3	10000 ohms	Terminals 1 & 7	80000 ohms

Teletype: Yonkers, N. Y. 3633

BURNELL & CO., INC.
YONKERS 2, NEW YORK
Pacific Division: 720 Mission St., S. Pasadena, Calif.

FIRST IN TOROIDS, FILTERS AND RELATED NETWORKS

WIRE AND CABLE FOR EVERY ELECTRONIC PRODUCT



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WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

2-8

The National Merit Scholarship Corporation

Business is Offered Big Dividends on Investment in Higher Education

The McGraw-Hill Publishing Company is availing itself of the opportunity to establish ten National Merit Scholarships. They will be known as the McGraw-Hill Merit Scholarships. The scholarships are to be awarded to qualified candidates for a four-year college course in the fields of science, engineering and the other professions and the liberal arts. There will be no limitation, beyond the appropriate professional accrediting, on the college or university selected by a successful candidate. As part of a continuing program to aid higher education and educational institutions, McGraw-Hill is happy to be able to share in what it believes to be the constructive educational endeavor of the National Merit Scholarship Corporation.

Business firms searching for a satisfactory avenue to provide financial aid for our colleges and universities now have a new opportunity of major importance. It is provided by the National Merit Scholarship Corporation, which has offered to devote $8 million to matching, dollar for dollar, gifts by business firms for college scholarships and supplemental gifts to the institutions where the scholarships are used.

The National Merit Scholarship Corporation, an independent agency financed initially by gifts of $20 million from the Ford Foundation and $500,000 from the Carnegie Corporation, has three major purposes which are closely related. They are:

1. To locate those of the nation's young men and young women who are best equipped to go to college.

2. When necessary, to help these young people go to college by giving them financial aid.

3. To help colleges and universities meet the full cost of the instruction of those to whom National Merit scholarships are granted.

At present about half of the nation's top high school graduates do not go to college. The principal reason is that they do not have the money required.

To Save Unused Brain Power

The National Merit Scholarship Corporation will strive to eliminate this dangerous neglect of top-flight ability. To this end it is inviting the nation's high schools, numbering more than 24,000, to participate in its program by designating as available candidates for National Merit scholarships the top 5 percent of their senior classes. Those so designated are then invited to take a series of tests and to submit reports designed to assure selection of the very best talent in each state. The number of scholarships to be allotted to each state will be proportionate to the number of high school graduates in the state.

The winners, the total number of whom will be determined by the amount of money the Scholarship Corporation has available, will be eligible for awards. For those who need no financial help to go to college there will be honorary awards of $100. For those who must have help the Corporation will grant scholarships covering as much as necessary

of the cost of instruction and living expenses for a four-year college course.

Colleges Get Financial Help

The provision of funds to cover the students' expenses does not, however, solve the financial problems faced by many colleges. That is because the tuition charges paid by the students do not cover the cost of the instruction. The deficit must be met by drawing upon endowment funds, gifts, grants, and other available sources.

Consequently, to prevent holders of National Merit scholarships from imposing any additional financial burden on the colleges and universities they elect to attend, the Corporation will make a supplementary grant to these institutions. The supplementary grant will be the equivalent of regular tuition charges made by the school, with a top limit of $1,500 a year for both the tuition and the supplement.

As the scholarship grants to the winning students will vary, depending upon how much financial help they need, so will the supplementary grants vary from one college to another, depending on their regular tuition charges. However, it is anticipated that on the average the full cost of a National Merit scholarship—including aid to the student and the supplement to the college—will be about $1,500 a year.

Many business firms will find a compelling appeal in a program which is designed at once to mobilize the nation's intellectual resources more effectively and, in the process, give very badly needed financial help to our colleges and universities.

Two For One Return Offered

However, there are numerous other inducements to business firms to finance National Merit scholarships. These scholarships may:

1. Carry the name of the firm or be named in honor of someone designated by the firm.

2. Be limited to use in types of colleges of particular interest to the sponsoring firm.

3. Be limited to a college course, such as science, engineering or liberal arts, of special concern to the sponsor.

4. Be restricted to candidates or institutions in geographic areas specified by the sponsor.

In addition to these advantages there is a special financial inducement to help the Merit Scholarship program. It is that for every Merit scholarship a firm or individual finances, the Corporation will, up to the limit of $8 million, match the funds and make another National Merit scholarship available.

There are many good ways of helping our financially beleaguered colleges and universities, and many corporations are already using one or more of them.* For those companies that can do so without embarrassing complications one of the best ways is to make unrestricted gifts directly to the institutions. But this new way provided by the creation of the National Merit Scholarship Corporation (Address: 1580 Sherman Avenue, Evanston, Illinois) has the broad appeal of serving two purposes of transcendent importance simultaneously. The purposes are to see that our best brains are fully trained and utilized and that our colleges and universities, crucial contributors to this process, are helped at the same time. Business will serve the nation and its own community well by giving the National Merit Scholarship Corporation generous help.

---

* These, as well as the plight of our colleges and universities, are discussed in a pamphlet, "Business Aid to Our Colleges and Universities," which embodies a series of five editorials which appeared in all McGraw-Hill publications. Copies of the pamphlet can be obtained without charge by addressing the Department of Economics, McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York 36, New York.

Methods of helping our colleges and universities financially are also outlined and discussed in a pamphlet, "Aids to Corporate Support of Higher Education," which may be obtained without cost by addressing the Council for Financial Aid to Education, 6 East 45th Street, New York 17, New York.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Farnsworth
IS EXPERIENCE!
MISSILES
INDUSTRIAL ELECTRONICS
RADAR
ELECTRON TUBES
RESEARCH
FOR OVER 10 YEARS . . . .
Since the beginning of our country's missile activity . . . Farnsworth has participated in the design, development and production of electronic equipment for such missiles as Terrier, Talos, Sparrow and others. This tremendous background of technical skills and know-how qualifies Farnsworth — uniquely — to cope with all phases of a missile program.
FOR OVER 30 YEARS . . . .
Farnsworth has carried on an unbroken tradition of achievement in defense and industrial electronics. The genius that created electronic television, pulse techniques, electron optics and photomultipliers, continues to lead advances in radar, special purpose tubes and electronic research.
This is Farnsworth . . . pioneer in electronics . . . dedicated to the extension of man's VISION beyond the range of sight.
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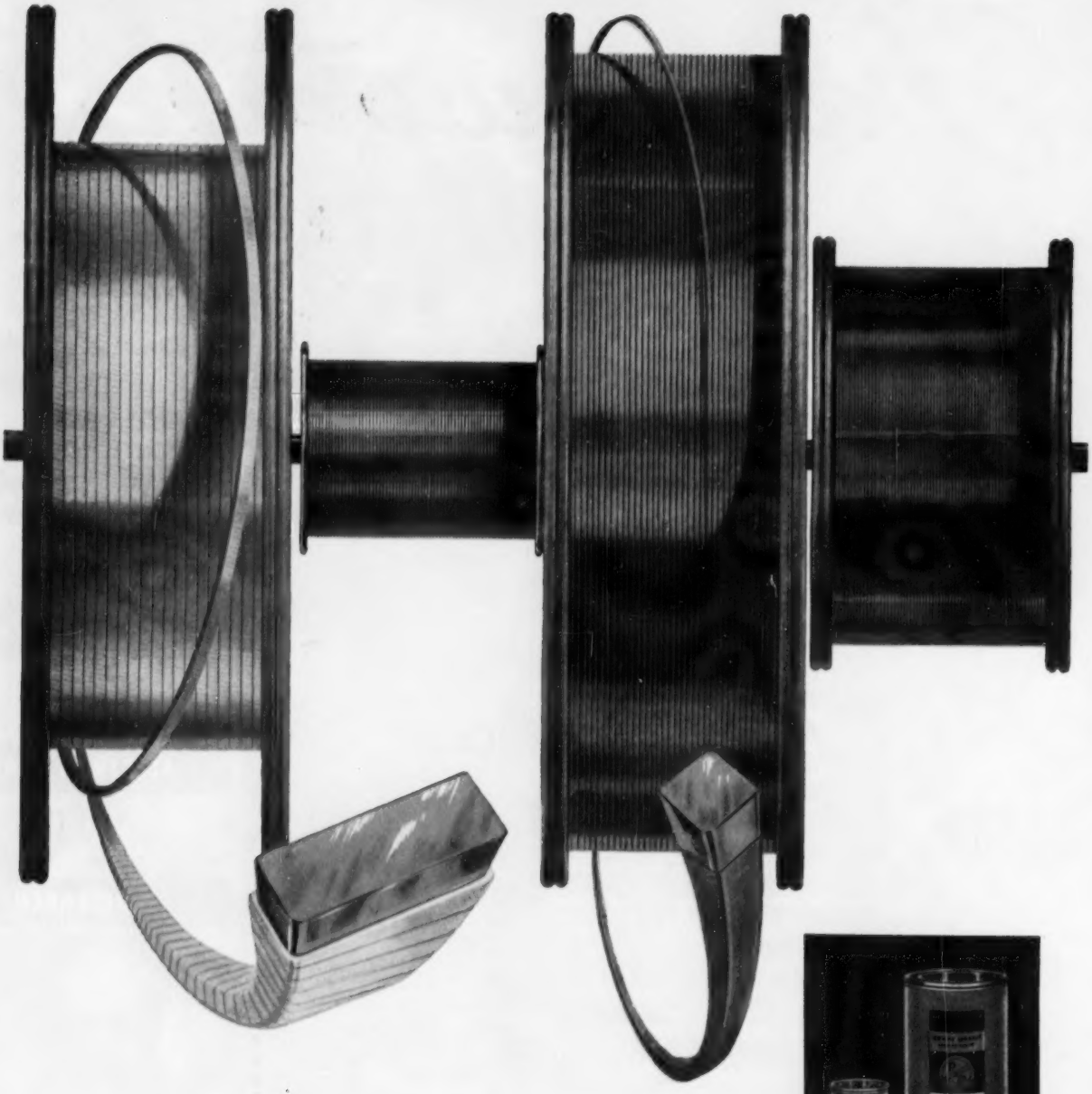
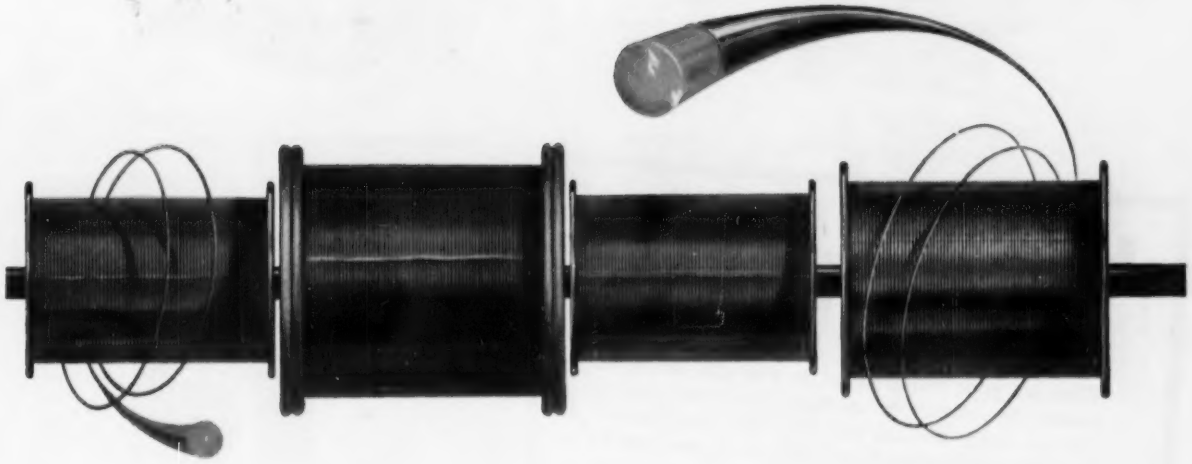
FE
I T & T
FARNSWORTH ELECTRONICS COMPANY
a division of International Telephone and Telegraph Corporation
FORT WAYNE, INDIANA



Wire packaged in Phelps Dodge special "Pakeze" containers if required.

First for Lasting Quality—from Mine to Market!



If it Calls for **MAGNET WIRE**—*Call on* **PHELPS DODGE** *for*

INDUSTRY'S MOST COMPLETE, MOST UP-TO-DATE LINE!

Every type of insulation to meet design requirements.
Enamel • Formvar • Sodereze® • Bondeze® • Daglas® • Thermaleze®
Silicone • Paper • Cotton • Multiple Combinations.

Available in all sizes and shapes—round, square, rectangular.
Over 400 different types!

Special emphasis on research and development—your assurance of the latest advances in magnet wire.

Vast background of application engineering experience to help solve your problems.

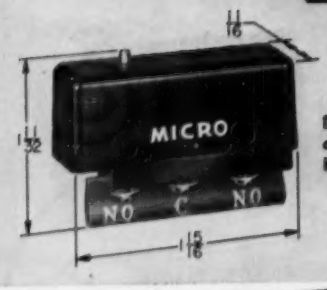
PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

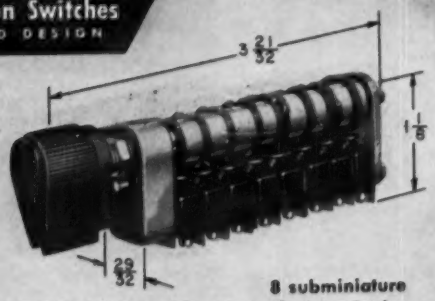
Want more information? Use post card on last page.

MICRO SWITCH Precision Switches

A PRINCIPLE OF GOOD DESIGN



Double-pole, double-throw basic switch



8 subminiature SPDT switches with rotary selector actuator

Here are 6 reliable precision switches for multiple circuit control

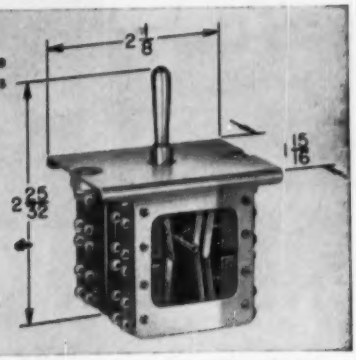
Whether your requirement is a single switch to control one circuit or an assembly of switches to control many circuits you will find that MICRO SWITCH engineering keeps pace with your needs.

Pictured here are just a few of the many small, sensitive, precision switches MICRO SWITCH has developed to meet specific applications. Push button, toggle and rotary actuators permit extreme versatility of design without any compromise with reliability.

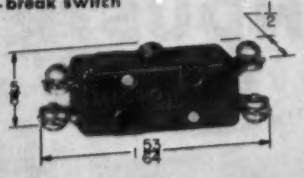
Should your design call for special small switches for use with high temperatures, difficult environments, high inrush currents or unusual circuitry, for instance, MICRO SWITCH engineering can quickly put the proper switch in your hands.

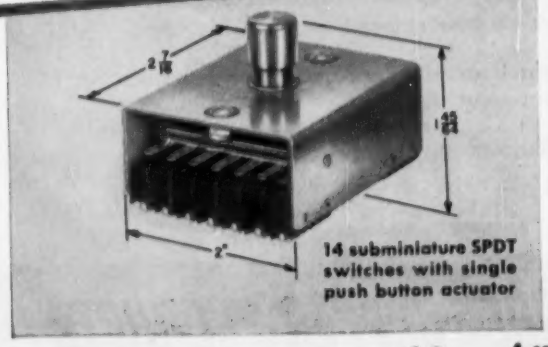
Call MICRO SWITCH engineering today. You'll be glad you did. There are 20 branch offices to bring you quick, intelligent cooperation on every switch problem. There is no obligation.

16 subminiature SPDT switches with toggle actuator



Two-circuit double-break switch





14 subminiature SPDT switches with single push button actuator

High capacity "V3" switches (may be gang-mounted)

A complete line of snap-action and mercury switches

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

Want more information? Use post card on last page.

. . . and cuts the size and weight of cable

Federal's miniature coaxial cables—about ¼ the size of comparable RG types—save critical space and weight in aircraft and instrument uses.

Challenged by the high temperature and minimum weight requirements of jet aircraft and guided missiles, Federal has designed RG cables that perform perfectly at a blistering 500° F.! New Federal miniature coaxials have a top temperature rating of 150° C. . . . up to 200° C. with an impregnated fiber glass jacket!

The key to these new cable developments lies in advanced designs.

Based on utilization of "Teflon," this superior dielectric maintains its excellent low loss and high voltage characteristics through a temperature range of 500° F. to −100° F. "Teflon" has no measurable water absorption; it is chemically inert . . . unaffected by alkalies, acids, aromatic fuels, aromatic organic solvents, and highly corrosive aviation hydraulic fluids.

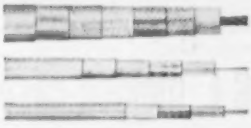
If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D913.

"TEFLON" HIGH TEMPERATURE CABLES

RG-87 A/U 50 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 4,000 operating volts.

RG-140/U 75 ohms; 69.5% V.P.; 29.5 mmfd/ft. Cap; 1,700 operating volts.

RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.



"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.

"TEFLON" HOOK-UP WIRE—Type E, EE and FF Hook-Up Wires meet MIL-W-16878A. Available in all standard colors.

Federal
A DIVISION OF IT&T

Federal Telephone and Radio Company

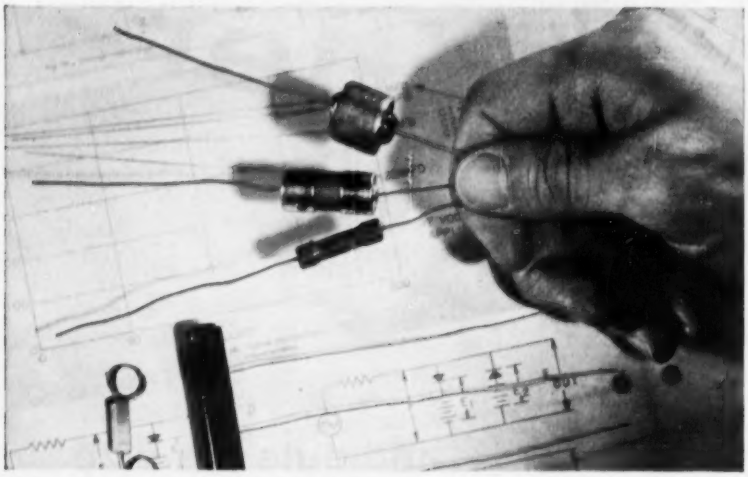
A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

DESIGNER'S

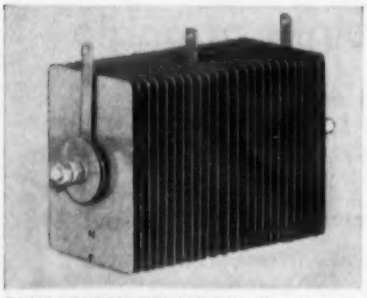
New G-E *Vac-u-Sel*® component rectifiers top 80,000-hour-life expectancy



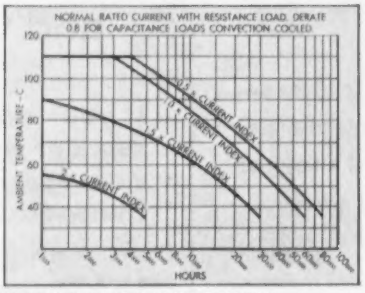
Life expectancy has now been raised from 60,000 to over 80,000 hours for General Electric's new miniature Vac-u-Sel rectifier stacks. Achieved by constantly improving processing techniques, this 20,000 hour increase in life is backed up by laboratory tests. Developed for electronic, industrial-control, and power applications, these units offer compactness and stability of electrical characteristics. Ambient temperature range is broad— −65 C to 130 C—and a wide variety of sizes, housings and finishes are available.

The "Selecto-Chart" shown below is part of a new application approach developed by G.E. It gives you greater freedom of design in selecting from the many rectifier sizes and types. Send for GEA-5935A, GEA-6273.

*Registered trade-mark of General Electric Co.



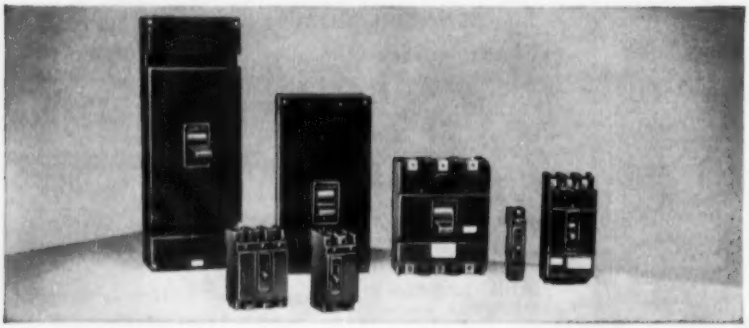
COMPACT RECTIFIER STACKS offer designers stable electrical characteristics.



INCREASE IN LIFE EXPECTANCY is shown in typical curves for 45-volt cells.

SELECTION IS EASY with new G-E Vac-u-Sel rectifier "Selecto-Chart."

G-E molded-case circuit breakers provide safe fuseless circuit protection



Thermal-magnetic trip elements in G-E molded-case circuit breakers help guard conductors against short circuits and sustained overloads. Operation is cool, life is lengthened through de-ionizing arc quenchers that quickly dissipate arcs.

Extra safety results from trip-free operating mechanism that opens contacts against overcurrents even if handle is held closed. Solderless lugs, straight-in wiring make installation simple.

Ratings from 10 through 600 amperes for circuits of 120, 240, 480, 600 volts a-c, and for 125, 250 volts d-c. GEC-1032.

—GENERAL ELECTRIC—

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. cuts radar transformer weights up to 35%

Small or large, narrow or wide, light weight, long life—whatever your requirements, General Electric will build high-voltage, oil-filled transformers and inductors to your specifications. The picture at left, for example, shows how G.E. cut 61 pounds from a typical radar power supply by redesigning with smaller embedded-layer coil. These corona-free components are suitable for many electronic applications other than radar.

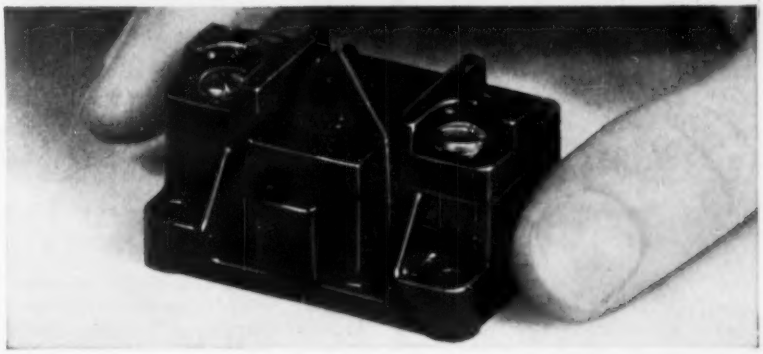
Among the advantages of these smaller and more reliable G-E components are: (1) more efficient cores permit weight savings to 11%, (2) alumina terminals add reliability, and (3) the use of Formex* wire and new embedded-layer winding techniques reduce coil sizes as much as 53%.

All G-E radar components are designed for compact installation. All can be manufactured to MIL-T-27 specifications. All have characteristics and features to meet a wide range of requirements. G.E.'s fully equipped model shop pools engineering and manufacturing skill to fulfill your needs. The shop can deliver prototype units for your experimental or system development projects—in a hurry—because work on your jobs begins immediately. Testing is strict. Vibration, thermal-cycling and moisture resistance tests are extra steps that can be taken by G.E. to assure components of the highest quality. Ask for Bulletin GEA-5963.

*Registered trade-mark of G.E. Co.

Two oz. switchette operates up to 50,000 ft. alt., from −70° F to 200° F

Versatile, corrosion-resistant and compact, General Electric Size 2 switchettes perform perfectly under extremes of altitude and temperature, combine low-inertia moving parts with high contact-tip force. Totally enclosed contact structure protects it from tampering and dirt. Screw-type terminals simplify wiring. For aircraft use where vibration is severe and space limited, its snap action and double-break-contact construction are especially valuable. Spring-return button on the housing can be actuated by lever, bellows, or other means. Bulletin GEC-207A.



EQUIPMENT FOR ELECTRONIC MANUFACTURERS

Components

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Capacitors
Transformers
Pulse-forming networks
Delay lines
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Motor-generator sets
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Photoelectric recorders
Demagnetizers

General Electric Company, Apparatus Sales Division
Section B667-32
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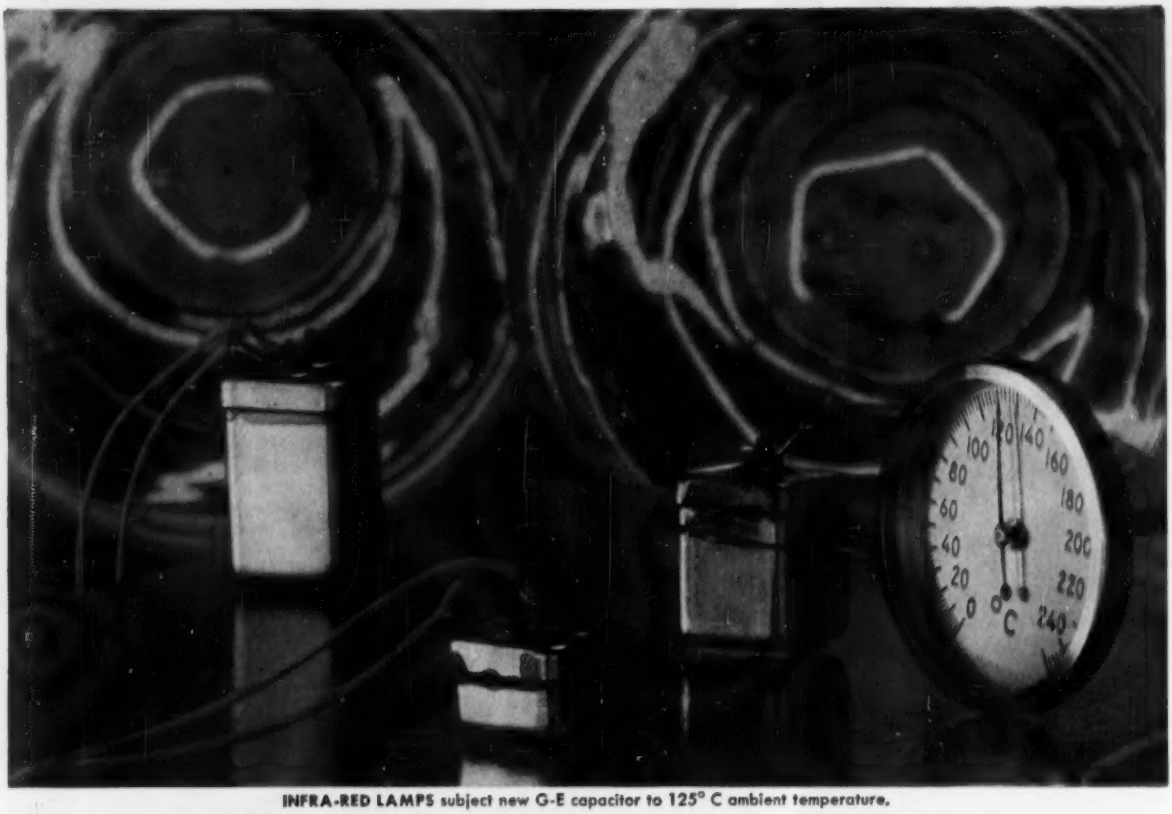
Please send me the following bulletins:

√ for reference only × for planning an immediate project

- ☐ GEA-5963 Radar Transformers
- ☐ GEC-207A Switchettes
- ☐ GEC-1032 Molded-case Circuit Breakers
- ☐ GEA-5935A Miniature Vac-u-Sel Rectifiers
- ☐ GEA-6273 New Vac-u-Sel Component Rectifiers

Name .....
Company .....
City ..... State .....

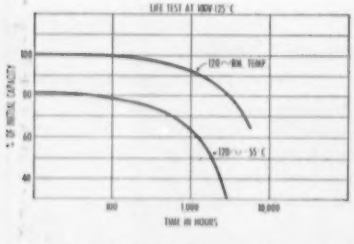
TURN PAGE FOR MORE G-E COMPONENT HIGHLIGHTS



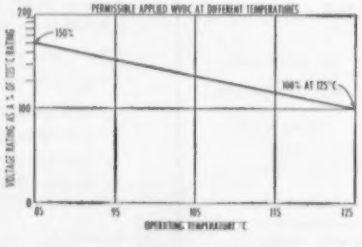
INFRA-RED LAMPS subject new G-E capacitor to 125° C ambient temperature.

New G-E high-temperature Tantalytic* capacitors operate in +125° C ambient at full voltage

Where quality, long life and small size are required in high-temperature, miniaturized, high-reliability equipment, specify General Electric's new 125° C Tantalytic capacitors. Designed to operate at full voltage in high temperature, they meet the tough requirements of miniaturized military equipment: energy storage, filtering, or by-pass applications in electronic ordnance, guided missile, navigation, communication, and control equipment.



LONG LIFE of G-E 125° C Tantalytic capacitors is shown by graph of life vs. loss of capacitance for typical 100-v d-c unit.



HIGHER VOLTAGES than 100 VDC can be applied with no life loss at ambients below rated +125° C as shown above.

Three rectangular case sizes permit ratings from 36 uf at 100 volts d-c to 180 uf at 30 volts d-c. All three sizes have same square base, varying only in height to maintain high volumetric efficiency at lower ratings.

Features: low leakage currents, long shelf and operating life, availability in polar and nonpolar construction for use in both a-c and d-c circuits. When operated at ambient of 125° C at rated voltage, units meet qualification requirements of 1000 hours with not more than 20 per cent loss in initial 25° C capacitance.

Unlike other types of Tantalytic capacitors, the foil construction offers chemically neutral electrolyte to minimize corrosion danger, plus excellent mechanical stability and freedom from electrical noise under shock or vibration. Ask for Bulletins GEA-6258 and GED-2620.

GENERAL ELECTRIC

DESIGNER'S DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

G.E. protects equipment with instantaneous voltage stabilization within ±1%

VOLTAGE STABILIZATION CHARACTERISTICS OF A TYPICAL STANDARD 115- OR 230-VOLT UNIT OPERATED AT VARIOUS LOADS
OUTPUT VOLTAGE
LOAD CURRENT
Output voltage is stabilized within two cycles as load current jumps from 0 to full load.
INPUT VOLTAGE
OUTPUT VOLTAGE
Output voltage is stabilized in less than 1½ cycles as input drops from 130 to 100 volts.
OUTPUT VOLTAGE
LOAD CURRENT
Output voltage is stabilized within two cycles as load current jumps from half load to full load.

General Electric voltage-stabilizing transformers are completely automatic. The compact units offer low losses, high input factor, fast response. They are easily installed, have no moving parts, and need virtually no maintenance. Often designers find standard units most satisfactory, either incorporated in new equipment or adapted to existing circuits. If special units are required, G-E engineers will co-operate in finding solutions for you. You can use them in literally hundreds of types of equipment. New applications and new methods of applying these voltage-stabilizing transformers are continually being discovered. The rapid responses of control with these units are shown graphically in the three curves at right, and typical characteristics above. Bulletin GEA-5754A.

G-E saturable reactors control individual power loads at low cost

Faced with fixed power sources, application and design engineers can draw on General Electric's "design pool" of more than 1000 different saturable reactor designs. This will simplify solving the problems they often face of controlling individual power loads manually or automatically at low cost. Very efficient even at light loads, a G-E saturable reactor provides control in an a-c circuit by direct current. Adjustment is smooth all the way. They can be satisfactorily utilized in a wide range of applications, including electrically heated furnaces and boilers, or milk pasteurizers and X-ray equipment. Apply them, too, in reduced-voltage starting, or continuously adjustable reactive load banks. G.E. can design them in a wide variety of a-c and d-c ratings to meet your special application needs. Bulletin GEA-6354.

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- ☐ GEA-6258 125C Tantalytic Capacitors
- ☐ GED-2620 Capacitors for Electronics
- ☐ GEA-6354 Saturable Reactors
- ☐ GEA-5754A Voltage Stabilizers

For information on other products, contact your nearest G-E Apparatus Sales Office.

Name .....
Company .....
City ..... State .....

Want more information? Use post card on last page.

this is not something new!

Leading members of the aviation industry have long known about this means of measuring aircraft and missile antenna radiation patterns. In the course of various engineering projects, they have come repeatedly to Airborne Instruments Laboratory with antenna test problems. As always, Airborne's scientists sought to create equipment, singularly perfect in performance yet flexible enough to meet many specific needs. Their efforts resulted in the Type 105 Model Range System, which automatically records polar plots of the relative field strength of aircraft radiation patterns.

The Type 105 System, however, is not only important within itself. Out of its totality have merged several significant devices, designed for many recording purposes. Among these are the 116R Polar Pattern Recorder, the Type 20 SWR Indicator, and the Type 373 Rectangular Coordinate Recorder.

Here again is an example of creative initiative, by AIL engineers, providing a continuous succession of advanced instruments for America's industrial progress.

Send for information about the 105 Model Range System and literature on other recording devices.

Type 373 Rectangular Coordinate Recorder

Type 20 SWR Indicator

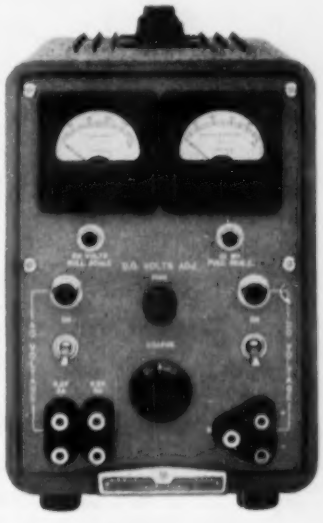
Type 116R Polar Pattern Recorder

AIRBORNE INSTRUMENTS LABORATORY INC

160 OLD COUNTRY ROAD • MINEOLA, NEW YORK

why fiddle and fuss?

New -*hp*- 711A Power Supply makes it easy to power experimental and bench setups



0-500 volts dc, 6.3 v ac
High regulation
Current, voltage meters
Overload protection
All-purpose utility

The new -*hp*- 711A was developed to do just one thing—simplify your job of powering all kinds of electronic circuitry in laboratory, field and factory.

This compact (18 lbs.) instrument is ideal for driving low level amplifiers, constant frequency oscillators and similar jobs where highly stable voltage is essential. Voltage range is very broad—0 to 500 volts. No-load to full-load regulation is better than ± 0.25% or 0.5 volts. Ripple is less than 1 millivolt.

For added convenience, there are separate current and voltage meters with new push-button range switching for accurate measurement of small voltages and currents. Other features include overload protection and grounding on either positive or negative dc terminals. The price is $225.

Electronic instruments for complete coverage, quality, convenience

HEWLETT-PACKARD COMPANY
3332A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.,
DAvenport 5-4451 • Cable "HEWPACK"
Field Representatives in all principal areas

Recessed-reversed Type "A" Angle Plugs and Set-in Interlock Panel Jacks.

AT HOME ANYWHERE . . .

HUBBELL *Interlock*

TRADE MARK

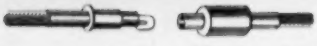
automatic locking . . . quick disconnect plugs make Voltage Tap Panel more flexible on

KLEINSCHMIDT TELEPRINTERS

Anywhere in the world Kleinschmidt Teleprinters are set up, they're completely at home! Designed to operate on alternating current, these modern teleprinter machines are quickly and easily adapted to use from 95 to 250 volts, simply by plugging the specially designed Interlock Angle Plugs into the proper receptacle on its voltage tap panel — an ideal arrangement when machines are moved from place to place.

While connected, Interlock plugs provide a constant, low resistance contact that cannot disconnect accidentally. A vibration and impact proof contact is made on two surfaces under constant coil spring pressure, which adjusts automatically with changes in pressure or temperature.

There is . . . or can be designed an INTERLOCK CONNECTOR For Every Wiring Problem



Type "A" Plugs and Jacks Insulated and Non-Insulated. Current Cap. — 10 amps., Wire Sizes #14 to #18

Type "B" Plugs and Jacks (Miniature) Insulated and Non-Insulated. Current Cap. — 5 amps. Wire Sizes #18 to #22

Type "C" Plugs and Jacks (Sub-miniature) Current Cap. — 1 ampere, Wire Sizes #20 to #22 or smaller

Type "S" Plugs and Jacks Current Cap. — 15 amps. Wire Sizes #14 to #18

Type "S" 4 in 1 Test Prod Kit (8 interchangeable test tips)

For Further Information, Write Dept. A:

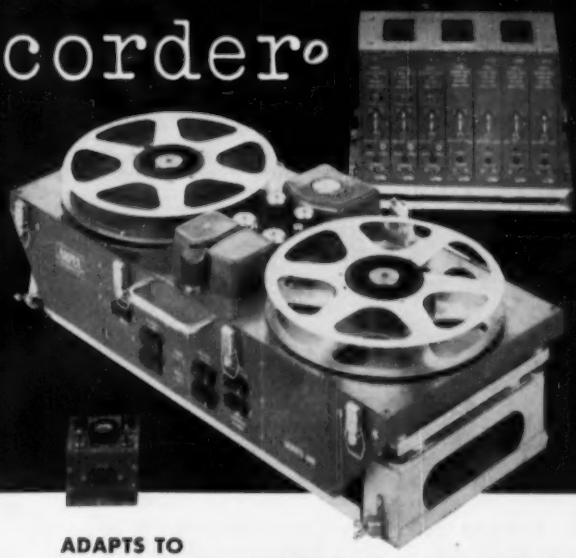
HARVEY HUBBELL, INC.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

HUBBELL REG. U.S. PAT. OFF.

SELF-LOCKING HUBBELL CONNECTORS Pats. & Pdg. Pats.

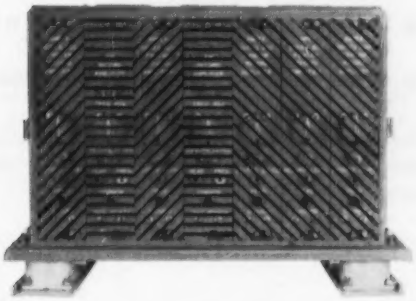
new versatile data tape recorder



THE MOBILE AMPEX 800

records the broadest combination of data ever obtained concurrently on one magnetic tape—performs with laboratory precision under severe field, airborne, shipboard and vehicular conditions—and furnishes data compatible with the most widely used playback equipment.

The Ampex 800 can provide from 1 to 28 data channels. By interchangeable amplifier units, each one can be adapted to any one of three basic magnetic recording techniques:



Direct recording — 300 to 35,000-cycle response for wide-band data or multiple recording of RDB subcarriers.

FM-carrier type recording — D.C. to 5000 cycles and high instantaneous accuracy suitable for shock and vibration data.

Pulse-width modulation recording — Up to 90 instrument readings commutated on to each tape track with frequency response 0 to 2 cycles/sec. With fewer instrument readings, frequency response is greater.

ADAPTS TO ANY DATA REQUIREMENT The Ampex 800's three available recording techniques can satisfy practically any test requirement by simple insertion of the proper plug-in amplifiers. Separate channels can be assigned to measurements requiring wide-band response or high transient accuracy. And by using pulse-width techniques, many relatively steady instrument readings can be commutated on to a single channel. All will have a common time base.

WITHSTANDS THE RIGORS OF AIRBORNE, SHIPBOARD, VEHICULAR AND GENERAL MOBILE USE The Ampex 800 will perform within specifications under vibrational forces as high as 10G—operates over a temperature range from −65°F. to 130°F.—is unaffected by altitudes to 50,000 feet—and withstands a relative humidity of 100% up to 122°F. The Ampex 800 is light in weight. It operates on 27.5 volts D.C. and 115 volts, 400 cycle, A.C. All operating functions can be remotely controlled.

RETAINS WIDELY ESTABLISHED RECORDER STANDARDS The majority of all magnetic recorders now in instrumentation use are Ampex machines. Their recording characteristics, tape speeds, track widths and other parameters have become standards. The Ampex 800 retains these while greatly extending the environmental and mechanical conditions under which accurate test data can be gathered.

Performance specifications, descriptions and explanations have necessarily been limited by the space on this page. A full description and detailed specifications on the Ampex 800 are available by writing Dept. E2338

AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

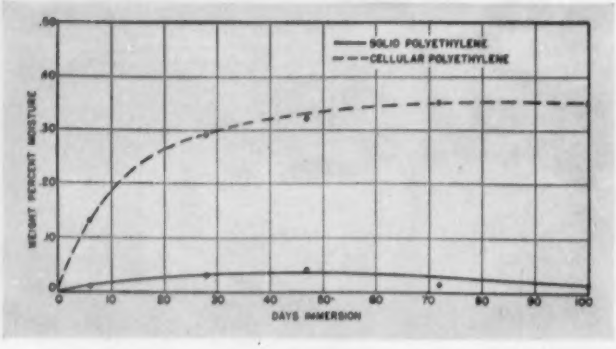
934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Branch Offices: New York; Chicago; Atlanta; San Francisco; Dayton; College Park, Maryland (Washington D.C. area)

Distributors: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company, Canada

FACTS YOU SHOULD KNOW ABOUT

CELLULAR



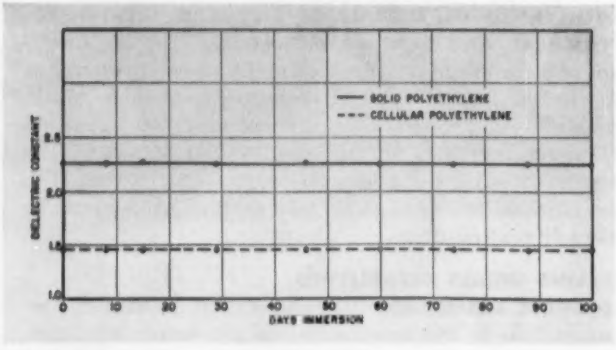
1. Moisture absorbed vs. days of immersion in tap water at 23 deg. C. Since BAKELITE Cellular Polyethylene is made up of hollow cells completely separated by walls of BAKELITE Polyethylene, its moisture absorption is low.

BAKELITE Brand *Cellular* Polyethylene for wire and cable insulation is a superior low-loss plastic that consists structurally of unconnected hollow cells. It is produced by the formulation of solid polyethylene with a foaming agent which, at the time of extrusion causes expansion to a cellular form. Properly extruded, the material will expand 100 per cent, giving a density about half that of solid polyethylene.

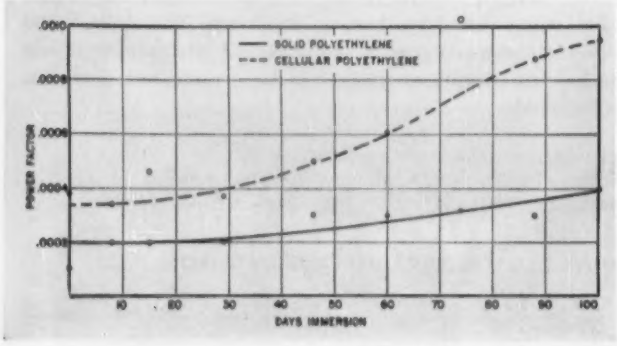
These are the principal advantages of BAKELITE Cellular Polyethylene for high-frequency electronic service:

- **Low order of moisture absorption (Fig. 1).**
- **Lower dielectric constant than that of solid polyethylene (Fig. 2).**
- **Low power factor, comparable to that for solid polyethylene (Fig. 3).**
- **Dielectric constant directly related to density formulation, while power factor remains uniform (Fig. 4).**
- **Uniformly low power losses over a broad frequency range (Fig. 5).**
- **Minimal power losses over wide temperature range (Fig. 6).**

For more information on the properties, fabrication, and use of BAKELITE Cellular Polyethylene, write Dept. ME-50.



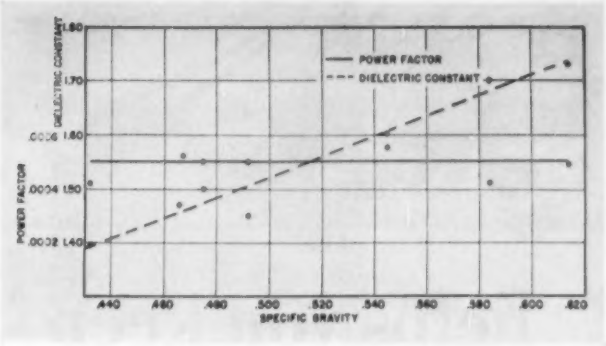
2. Dielectric constant at 1 megacycle vs. days of immersion in tap water at 23 deg. C. Note that BAKELITE Cellular Polyethylene retains its dielectric constant—considerably lower than that of solid polyethylene—throughout long immersion periods. The lower dielectric constant results in insulated conductors with a lower capacitance per foot than when the solid material is used.



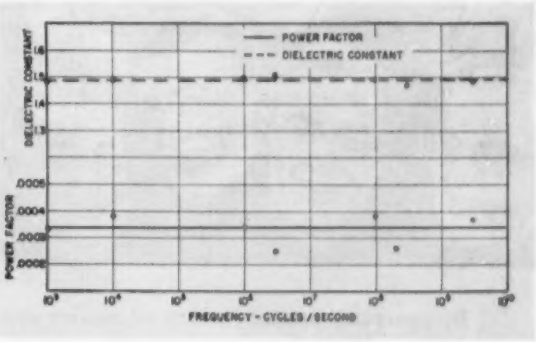
3. Power factor at 1 megacycle vs. days of immersion in tap water at 23 deg. C. Even after extended periods of water immersion, BAKELITE Cellular Polyethylene demonstrates a low power factor.

POLYETHYLENE

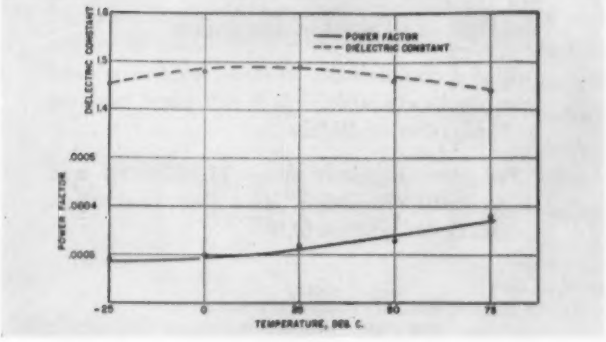
FOR WIRE AND CABLE INSULATION



4. Power factor and dielectric constant at 1 megacycle vs. specific gravity. BAKELITE, Polyethylene has a dielectric constant about midway between that of solid polyethylene (2.3) and that of the inert gas yielded by the blowing agent (1.0). Its value depends on the degree of expansion of the foam. The low power factor remains uniform.



5. Power factor and dielectric constant vs. frequency. Both the power factor and dielectric constant of BAKELITE Cellular Polyethylene are relatively unchanged over a broad frequency range, indicating that power losses will be uniformly low.



6. Power factor and dielectric constant at 1 megacycle vs. temperature. These properties of BAKELITE Cellular Polyethylene are consistent over a considerable operating temperature range, indicating minimal power losses due to seasonal variations.

BAKELITE
BRAND
POLYETHYLENE

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario
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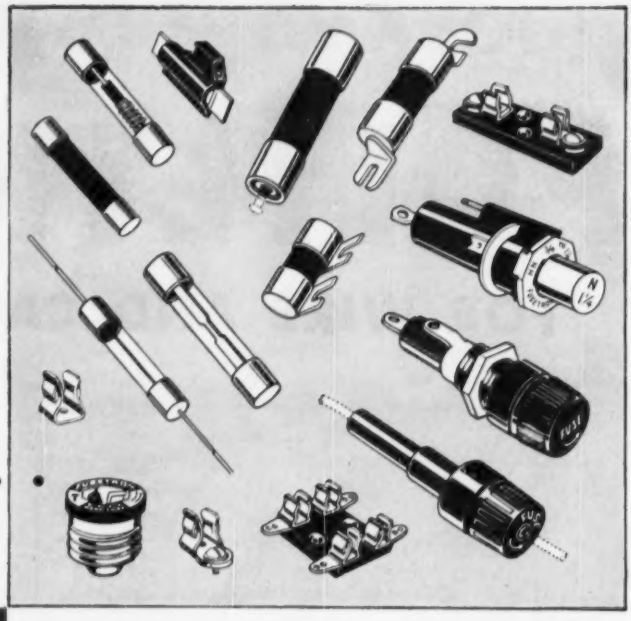
The unfailing Dependability of BUSS FUSES . .



helps you keep customers satisfied !

By operating properly under all service conditions — BUSS fuses can help safeguard the reputation of your product or service against loss of customer good will.

When there is an electrical fault — BUSS fuses open and prevent further damage to equipment, saving users the expense of replacing needlessly burned out parts.

And just as important, BUSS fuses won't give a false alarm by blowing when trouble doesn't exist. Useless shutdowns caused by poor quality fuses blowing needlessly are not only irritating to customers — but customers' confidence in your product or service could be jolted.

Every BUSS fuse is electronically tested to assure "trouble-free" operation.

Every BUSS fuse normally used by the Electronic Industries is electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

With a complete line of fuses, fuseholders and fuse blocks available — it is just good business to standardize on BUSS.

For more information on FUSETRON and BUSS small dimension fuses and fuseholders . . . Write for bulletin SFB.

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.

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ELRC
1255

BUSS FUSES ARE MADE TO PROTECT — NOT TO BLOW

which way* to measure jet engine performance?

Actual photograph

KOLLSMAN PRESSURE RATIO THRUSTMETER
used on Convair's F-102 and McDonnell's F-101

thrustmeters

to indicate PRESSURE RATIO...to indicate DIFFERENTIAL PRESSURE

KOLLSMAN is in production...

on components for BOTH TYPES—for Remote or Direct reading

For over a quarter century, Kollsman has been making precision pressure sensitive mechanisms using displacement type diaphragms. This diaphragm can be called the heart of a thrustmeter pressure indicating system.

Our long experience making displacement type diaphragms guarantees reliable thrustmeters.

Proven Kollsman displacement type diaphragms, when fitted with Kollsman Synchrotels, comprise the transmitters for remote indicating types. Thousands of Synchrotels are now in use in other applications equally demanding of accuracy and durability.

Tailor-made Thrustmeters can be supplied for any engine-airplane combination. Write for complete technical information.

TYPICAL SYSTEM OPERATIONAL DATA

1. Accuracy: .015 in 100% of readings at room temperature.
   .025 in 85% of readings at −55°C and +70°C.
   .035 in 15% of readings at −55°C and +70°C.
2. Altitude: No specific limitation.
3. Power: 115V, 400CPS, single phase, 18VA
4. Pressure Ratio Range: 1.2 to 3.4
5. Pressure Ranges (operating):
   Pt_2=2 to 50" Hg. Abs.
   Pt_7=2.4 to 100" Hg. Abs.
   Pt_7-Pt_2=0.4 to 70" Hg.
6. Temperature Range: −55°C to +120°C
7. Weights:
   Transmitter: 2.2 lbs.
   Indicator (including integral amplifier): 1.8 lb.
8. Response: Full Range in 7 seconds.

**The Pressure Ratio System has advantages for indicating optimum climb and cruise throttle setting, whereas the Pressure Differential System has a definite advantage at take-off.*

Kollsman activities cover these seven fields:

AIRCRAFT INSTRUMENTS • PRECISION CONTROLS
PRECISION COMPUTORS AND COMPONENTS • OPTICAL COMPONENTS AND SYSTEMS
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT • MOTORS AND SYNCHROS
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kollsman INSTRUMENT CORPORATION

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"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company

Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.

Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

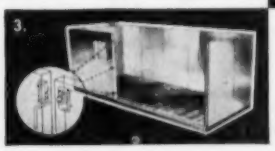
Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

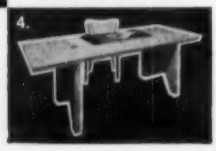
SIMMONS FASTENER CORPORATION
1750 N. Broadway, Albany 1, New York

Simmons

QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK

FASTENERS WITH USES UNLIMITED

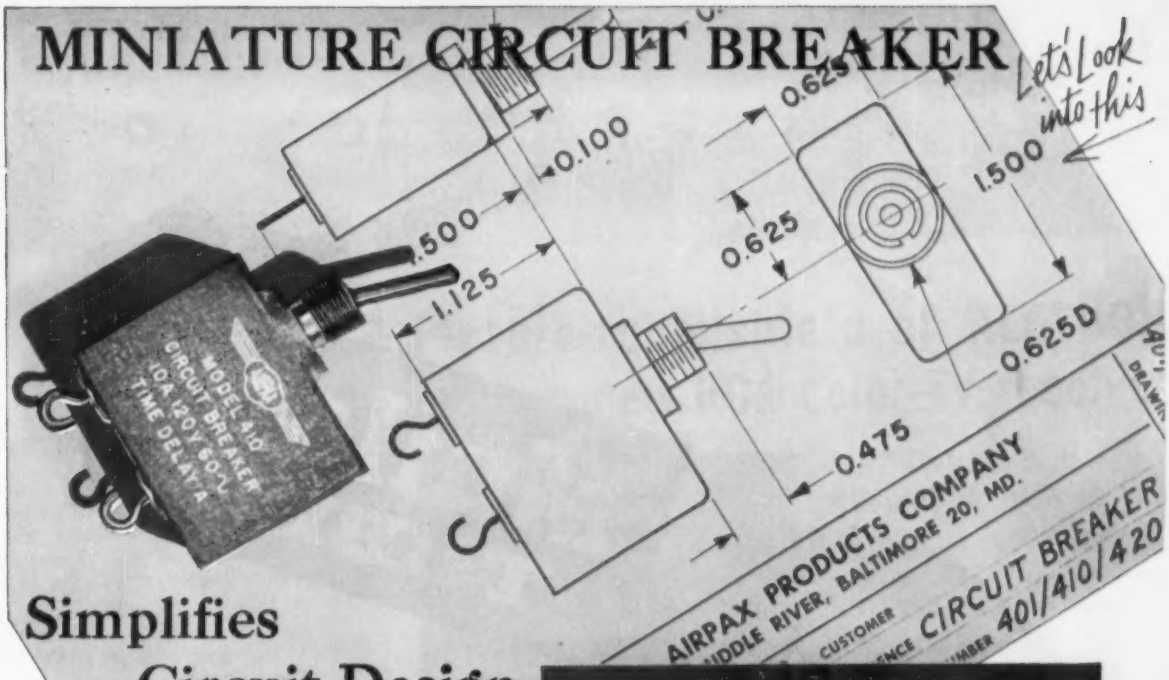




Some applications of Roto-Lock:

1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk

MINIATURE CIRCUIT BREAKER



Simplifies Circuit Design

You can now perform the *two* functions of power ON-OFF control and circuit protection with *one* miniature fully magnetic time-delay trip-free circuit breaker. Save space (see diagram above); save weight (weighs less than 2 oz). The characteristics (tabulated at right) of this new Airpax component show it to be a significant advance in power control; just what you need.

Handle has ON and OFF positions; it moves to OFF position when breaker trips, yet breaker cannot be prevented from tripping by holding handle in ON position. Stable tripping mechanism assures reliable operation even under adverse temperature and vibration. Give your equipment the protection it deserves.

To restore service after fault has been removed, simply reset the breaker. A breaker having a 30-sec time delay recovers full delay in about 20 sec.

To receive complete engineering data, simply write to

CHARACTERISTICS

RATINGS: 0.05 amp to 10 amp at 50 V DC or 1.0 to 10 amp at 120 V AC

MINIMUM TRIP: 125% of rated load

INSTANTANEOUS TRIP: 1,000% of rated load

INTERRUPTING CAPACITY: a typical value is 500 amp at 30 V DC

POWER CONSUMPTION: 0.6 watt in lower current ratings, rising to about 2 watts at 10 amp rating

SHOCK: resists 50 g in all directions

VIBRATION: 10 to 55 CPS at 0.06 in. total excursion in all directions

TEMPERATURE: −40 C to +100 C

LIFE: 10,000 operations at rated current into resistive load

ENCLOSURE: hermetically sealed

AIRPAX

ENGINEERS DESIGNERS

MIDDLE RIVER BALTIMORE 20, MD.

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The greatest Names in British Electronics use

Mullard
TUBES

British equipment manufacturers are making a vital contribution to the developement of electronics in all fields of application.

Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Supplies of Mullard tubes for replacement in British equipments are available from the companies mentioned below:—

In the U.S.A.	International Electronics Corporation, Department E12, 81, Spring Street, N.Y. 12. New York, U.S.A.
In Canada	Rogers Majestic Electronics Limited, Department ID, 11-9 Brentcliffe Road, Toronto 17, Ontario, Canada

MEV32

Mullard

Electronic Tubes — used throughout the world

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, ENGLAND.

Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world

DU PONT

Better Things for Better Living
. . . through Chemistry

ELECTRONIC DESIGN NEWS

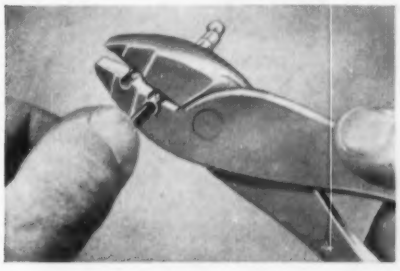
PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Interlock plugs insulated with ZYTEL® easily crimped for solderless connections

Interlock Type B plugs are now available with jackets of Du Pont "Zytel" nylon resin to prevent shocks and shorts. This insulation of "Zytel" protects the complete plug except contact points – allows plugging in or disconnecting with greater safety.

"Zytel" has excellent crimping properties – the terminal can be crimped tight enough for a good connection without any danger of the insulation cracking and exposing the live portion of the plug.

Use the coupon below for complete property information on this tough, durable insulating material – Du Pont "Zytel" nylon resin.



This interlock Type B plug insulated with Du Pont "Zytel" nylon resin can be easily crimped and has excellent dielectric properties. Plug manufactured by Harvey Hubbel, Inc., Bridgeport, Connecticut.

Laminations of TEFLON® for printed circuit bases

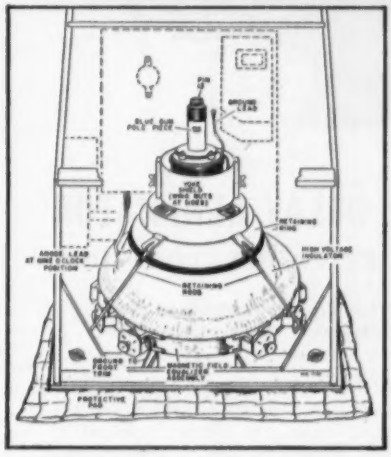
Typical uses of glass-cloth laminations of "Teflon" tetrafluoroethylene resin include:

1. Conductor insulation, slot and phase insulation and slot wedges (motors and generators).
2. Conductors and ground insulation, coil separators and layer insulation (transformers).
3. Hookup wire, power cables, ignition wire.
4. Printed circuit bases.
5. Structural parts.

The laminations combine the dielectric properties, chemical inertness and heat resistance of "Teflon" with the tensile strength, resistance to cut-through, and resistance to creep of woven glass fiber.

An informative free bulletin describing the preparation and uses of laminations and impregnations of glass cloth employing "Teflon" is now available. Write for a copy of Bulletin X-64.

Picture-tube shield of ALATHON® used in new RCA color-TV receiver



Shield of Du Pont "Alathon" serves as insulator for both the deflection yoke and kinescope retaining assembly on RCA Victor's new 21-inch color-TV set. (Kine shield molded of Du Pont "Alathon" polyethylene resin for RCA Victor by Sinko Manufacturing & Tool Co., Chicago, Ill.)

ALATHON® has high dielectric strength, is strong and lightweight

The picture tube in the new RCA Victor color-television receiver operates at 25,000 volts. To provide insulation for this tube, RCA Victor engineers needed a material that could be readily and inexpensively molded into the complex shape of a kinescope shield . . . yet had high dielectric strength. Du Pont "Alathon" polyethylene resin proved to be an ideal material for the shield on all counts. In addition to providing the needed insulation, the shield of "Alathon" gives mechanical protection to the tube when it is shipped or handled.

"Alathon" not only has excellent insulating properties but is strong, lightweight and flexible. It is chemical-resistant, as well as odorless, tasteless and non-toxic. Because of these properties, and the ease with which parts can be molded, extruded or fabricated, "Alathon" has helped engineers solve many design and operating problems.

Get complete property and application data on "Alathon," and on the other Du Pont engineering materials. Each has unique properties suited to a wide range of cost-saving applications. Clip and mail the coupon below.

NEED MORE INFORMATION?
CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

"Teflon," "Alathon," "Zytel" and "Lucite" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.).

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 2212, Du Pont Building, Wilmington 98, Delaware
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P.O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"* nylon resin; ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for_____

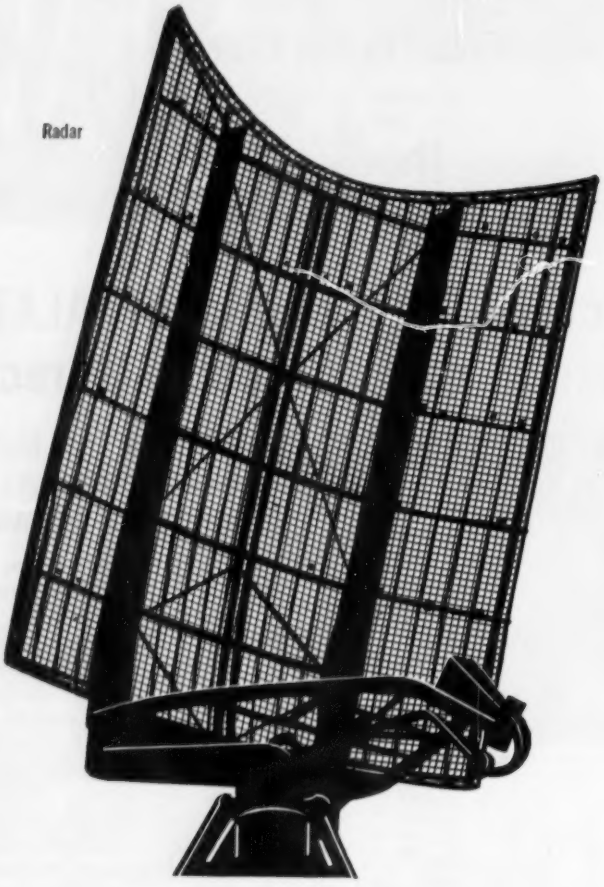
NAME_____

COMPANY_____ POSITION_____

STREET_____

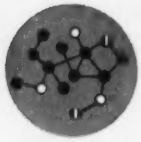
CITY_____ STATE_____

TYPE OF BUSINESS_____



Navigation

Timing


Nucleonics

Geophysics

Ordnance

PRECISION DIGITAL DELAY GENERATOR

FOR GENERAL-PURPOSE LABORATORY USE

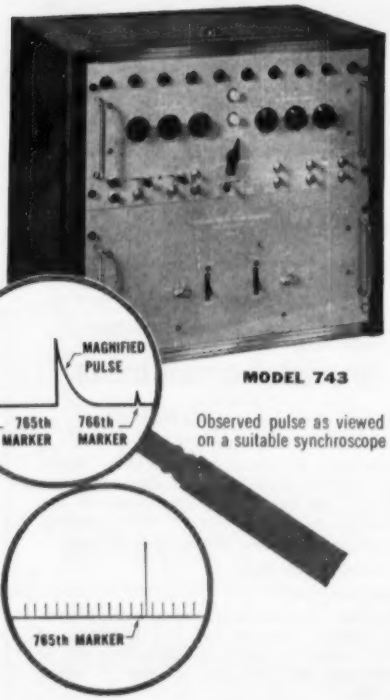
Generates pulses accurately spaced in time with respect to an internally generated reference pulse—range 0 to 100,000 microseconds

Complete generality permits numerous and varied uses such as radar range calibration, target simulation, generation of secondary frequency standards, elapsed time measurements, phase measurements, etc. Fields of application include Radar, Navigation, Telemetry, Nuclear Studies, Computor Research, Geophysics, Ordnance, and any other fields in which timing is significant.

The ability to generate a specific delay at accurate variable repetition rates sets this instrument apart from any other pulse or delay generator in the field today. Write for full details.

Pulses can be supplied under either one-shot conditions or at variable repetition rates. Both pulse delay and repetition period can be established in increments as small as 1 microsecond.

The repetition period can also be externally triggered, in which case two independently variable delayed pulses are available. Accuracy of both repetition period and pulse delay are held to one part in 10^5 by the thermostatically controlled crystal oscillator. The digital circuitry and the built-in self-checking features make continuous calibration unnecessary.



MODEL 743

Observed pulse as viewed on a suitable synchroscope

KAISER METAL PRODUCTS, INC.
BRISTOL, PA.

8 Dependable Solutions
TO HERMETIC SEALING PROBLEMS...

E-I HERMETICALLY-SEALED
TERMINALS
AND MINIATURE
CLOSURES

E-I Hermetically-Sealed Terminals and Miniature Closures are available to solve practically every electrical and electronic sealing problem. Recommendations on specific applications and samples will be sent promptly on receipt of your specifications or sketches. There is no obligation.

MULTIPLE HEADERS—Vacuum tight, cushioned glass construction. Strain-free, tin dipped for easy soldering and silicone treated for maximum dielectric strength.

OCTAL HEADERS—Plug-in and multiple types. Feature new principle of hermetic sealing. Solid metal blanks assure maximum mechanical strength and rigidity.

SEALED TERMINALS—Featuring cushioned glass construction, high thermal shock resistance. Available in economical preferred types and special designs.

TRANSISTOR CLOSURES—For transistors and other components requiring hermetic sealing. Available in standard types or custom design to specifications. Cases supplied round, rectangular or square.

END SEALS—For condensers, resistors and other tubular components. Completely strain-free and provide a permanent hermetic seal. Standardized, economical types.

LUG-TYPE, LEAD-THRU INSULATORS—For "bath tub" condensers, transformers, other applications requiring voltage ratings from 2000 to 4000 (rms.). Compression sealed, super rugged. Inside or outside mounting.

COMPRESSION TYPE HEADERS—Super rugged, absolutely rigid, practically indestructible multiple headers. Exclusive E-I development offers greatly increased resistance to shock and vibration.

COLOR-CODED TERMINALS—Feature glass inserts in standard, easily identified RMA color codes. Coloring is in the glass.

New Catalogs on Request—Illustrated literature on any of the above is available without obligation. Call or write for new bulletins, today!

***E-I**..HEADQUARTERS FOR HERMETICALLY-SEALED MULTIPLE HEADERS, OCTAL PLUG-INS, TERMINALS, COLOR CODED TERMINALS, END SEALS*

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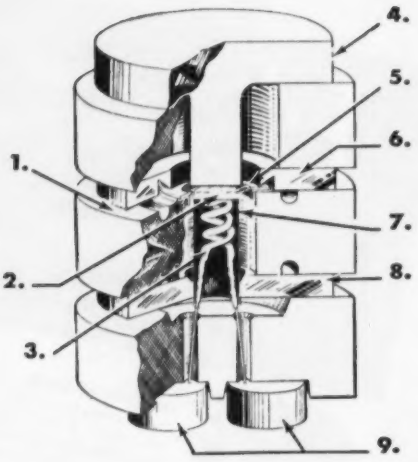
DIVISION OF AMPEREX ELECTRONICS CORPORATION

7-54

ELECTRICAL INDUSTRIES
44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

ADVANCED DESIGN OF NEW FEATURES METAL-



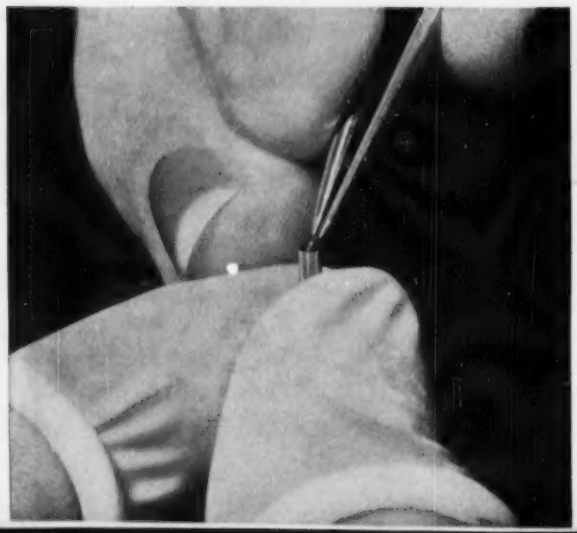
ONLY 3/8" HIGH! THE 6BY4 IS G.E.'S ULTRA-COMPACT NEW METAL-CERAMIC R-F AMPLIFIER TRIODE FOR UHF-VHF TV TUNERS.

Installs in a fraction of the space required by other tuner tubes—yet out-performs them! At 900 mc operation with 10 mc bandwidth, new tube has the low noise factor of approx 8 db, and a power gain of approx 15 db. Filament and plate voltages, 6.3 v and 200 v . . . amplification factor, 100. The metal-ceramic, parallel-plane design as illustrated in the cutaway, gives the new 6BY4 short electron transit time and an extremely low r-f loss; also high structural rigidity. In type 6BY4 this rigidity is employed to attain minimum microphonics rather than maximum tube resistance to shocks and vibration, since TV circuits do not undergo the same physical hazards as military and commercial airborne and mobile equipment.

1. Reference plane
2. Oxide-coated cathode
3. Heater
4. Anode
5. Grid
6. Grid ring
7. Support cylinder
8. Cathode ring
9. Heater buttons

Above: metal parts for G-E micro-miniatures are fired in a high-vacuum furnace. Titanium is employed—this substance has the unique advantage of freeing virtually all its own gases when fired to 700 C. Result of using pre-fired titanium parts: there is no subsequent vacuum contamination from metal-liberated gases when tubes operate at high temperatures. Instead, titanium serves as a gas absorber!

Right: in an operation calling for utmost delicacy, the tube's cathode disc is fitted into the support cylinder. Note rubber finger cots on the fingers holding the tiny cylinder! Changed hourly, these finger cots help ward off dirt and moisture—are worn when handling all micro-miniature tube parts, to keep the parts scrupulously clean. Other G-E aids to cleanliness are air-pressuring, air-conditioning, and lint-free Nylon and Dacron uniforms.



G-E MICRO-MINIATURE TUBES CERAMIC CONSTRUCTION

Heat-resistant! Micro-miniatures will operate up to 500 C!
The new G-E tubes withstand shocks and vibration; have high gain, minimum noise.

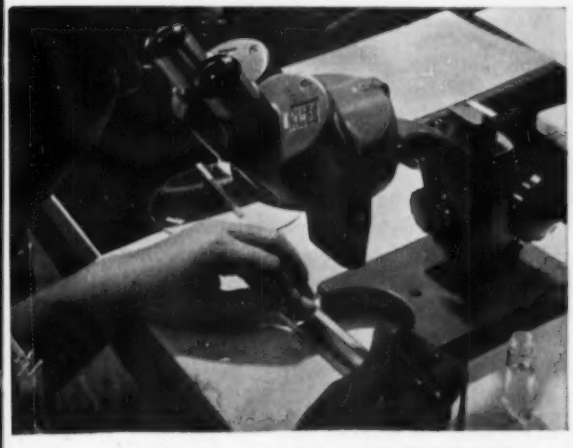
Breaking sharply with traditional concepts of tube design, G-E micro-miniatures are as new as the era of advanced electronic performance that lies directly ahead.

In structure, these extremely small, rugged tubes show a straightforward engineering approach to high electrical efficiency. The materials of tomorrow are used to achieve full-rating operation at high temperatures, with no sacrifice of service life or tube dependability.

Type 6BY4—tuner triode designed expressly for TV, no bigger than a pencil-eraser, amazingly low in microphonics—is the first of an outstanding new series of metal-ceramic micro-miniatures by General Electric. Designers of electronic equipment can meet new, exacting, commercial and military requirements by means of micro-miniature tubes—space-saving, virtually heat-proof.

Ask for full information! If your design problem is one calling for tube analysis . . . if your new circuit needs a special high-performance tube type —G-E tube engineers will be glad to consult with you. *Tube Department, General Electric Company, Schenectady 5, New York.*

Tube grids are carefully micro-inspected. High-power lenses give the necessary magnification to check G-E micro-miniature grids—for the 6BY4, wire only 3/10,000 inch in diameter, wound 1,000 times per inch! Special equipment, new techniques are used at every stage of micro-miniature assembly and inspection. These mark the highest precision standards attained in receiving-tube manufacture.

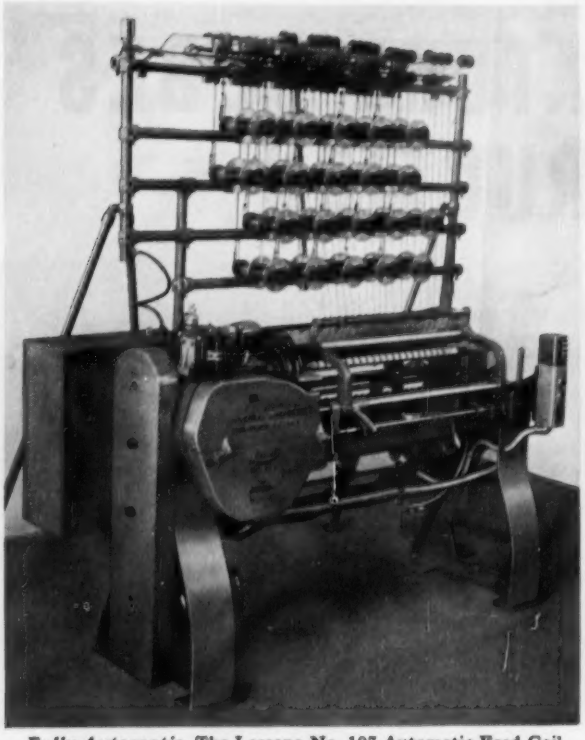


Importance of metal-ceramic research in the development of electronic tubes and other products, is accented by this new, separate Metals and Ceramics Building at the General Electric Research Laboratory, Schenectady, N. Y. Here G-E scientists, research engineers, and skilled workers investigate and measure metal and ceramic properties and performance under every possible condition that will be encountered.

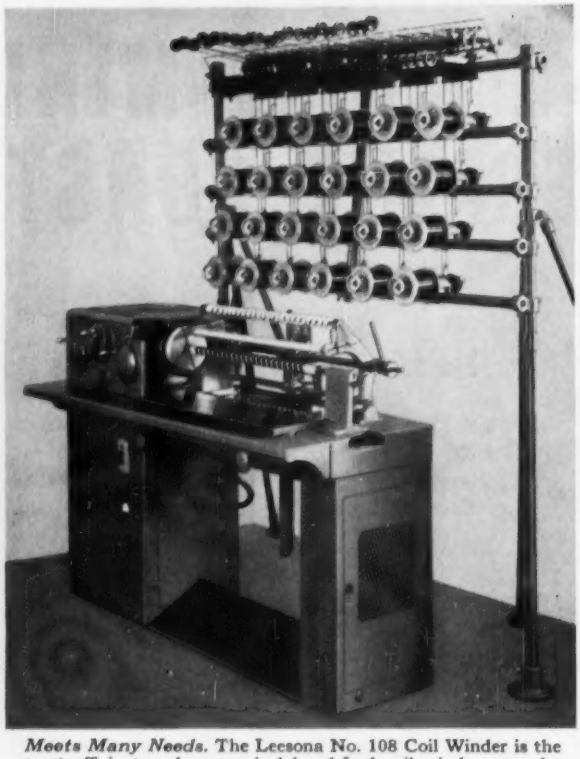
Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1AS



Fully Automatic. The Leesona No. 107 Automatic-Feed Coil Winder provides the quickest, easiest way to wind paper-insulated coils accurately. Winds four to thirty coils in stick form simultaneously. Safely handles wire sizes from No. 19 to No. 42 (B&S). Electronic drive assures a slow, smooth start that minimizes breakage when winding fine wires.



Meets Many Needs. The Leesona No. 108 Coil Winder is the most efficient and economical hand-feed coil winder ever designed. Winds four to thirty paper-insulated coils in stick form simultaneously. Reduces set-up time and cuts winding time and costs on long or short runs, for a wide variety of coils.

Now...*Get the modern, cost-cutting coil winders you need...with one of the two*

Leesona Pay-As-You-Profit Plans

Here's how many forward-looking plants are now meeting competition on even terms — or better.

They're eliminating the financial waste caused by obsolete or insufficient coil winding machinery. They're cutting operating and maintenance costs, and boosting production rates, with up-to-the-minute Leesona Coil Winders — secured through one of Universal's two famous Pay-As-You-Profit Plans.

These Plans provide the economies of modern coil winding production, while safeguarding your cash, capital position and borrowing power. Take your choice of:

I. *Leesona Long-Term Purchase Plan*

II. *Leesona Long-Term Lease Plan*

One of these Plans may be your long-sought answer to a major production problem — may enable you to make immediate operating cost cuts, while improving your competitive position. Investigate this fast, simplified, practical financing. For information about the Pay-As-You-Profit Plan that best meets your needs, contact your Universal Representative or write direct.

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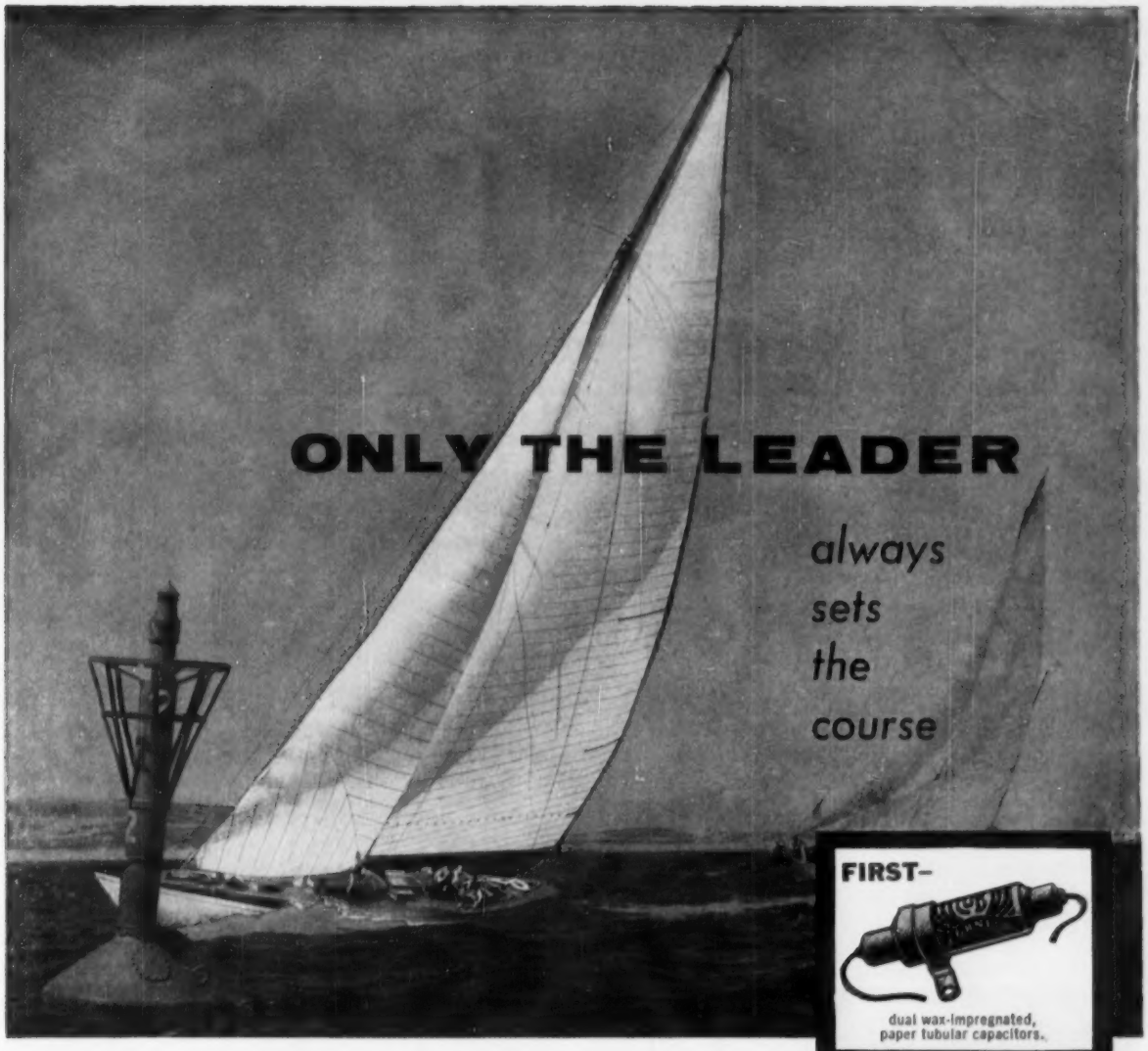
Want more information? Use post card on last page.



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WHICH TYPE. Tabulated dimensional information given on seamless, Lockseam*, and WELDRAWN† cathodes.

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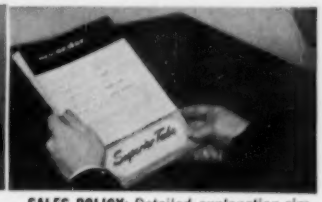

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3 SMALL SIZES—DCC ½ WATT
DCF 1 WATT and DCH 2 WATTS

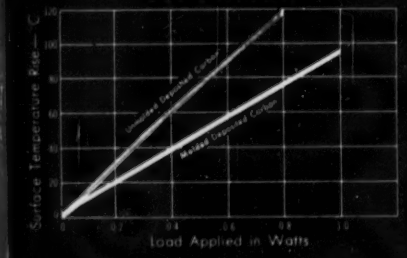
MEET ALL REQUIREMENTS OF MIL-R-10509A SPECIFICATION

Wherever the Circuit Says

Molded Deposited Carbon

Molded **Deposited Carbon resistors are now available from IRC in 3 sizes: Types MDA—⅛ watt, MDB—¼ watt and MDC—½ watt. The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics. These 1% precision film type units exceed MIL-R-10509A specifications.**

COMPARISON SURFACE TEMPERATURE RISE VS. LOAD
Molded vs. Unmolded Deposited Carbon Resistors



Boron Carbon

Where a high degree of accuracy under widely varying temperatures is required, IRC Boron Carbons offer an ideal combination of characteristics. Their superior temperature stability is provided in 3 sizes: Types BOC—½ watt, BOF—1 watt and BOH—2 watts—all 1% accuracy. Considering weight, size and cost factors, plus lower capacitive and inductive reactance, these film type precision resistors can satisfactorily replace wire wounds.

IRC TYPE	BOC	BOF	BOH
Equivalent MIL Style	RN 20R	RN 25R	RN 30R
Wattage (40°C. Ambient)	½	1	2
Max. Continuous Voltage	350 V.	500 V.	750 V.
Minimum Ohms	10	20	30
Maximum Ohms (IRC)	0.5 meg	2.0 meg	5.0 meg

IRC

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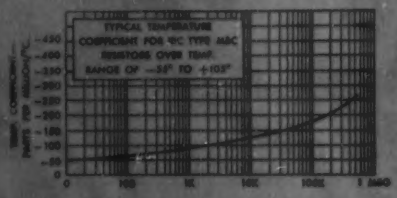
Molded Boron Carbon

Only from IRC can you obtain Boron Carbon resistors with the protection of a *molded* plastic housing. Any risk of mechanical damage to the coating or of insulation breakdown is overcome. Any need for special handling is eliminated, and moisture and load life characteristics are improved. 3 sizes—Types MBA ⅓ watt, MBB ¼ watt and MBC ½ watt—all exceed MIL-R-10509A specifications.

TYPICAL TEMPERATURE COEFFICIENT



Wire Wound

IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. IRC Mil Type precision wire wounds meet all requirements of MIL-R-93A specification. In addition to 6 Mil sizes, IRC supplies tiny Type WW10J—1½ x ⅜". Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	IRC MIL TYPES	TYPE WW10J
10 ohms & up	0.1%	
5 ohms & up	1.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

Encapsulated Wire Wound

Tru-Mite encapsulated wire wound precision resistors are produced to IRC's high standards by its West Coast subsidiary, IRCAL INDUSTRIES. Available in 11 sizes and axial lead or lug types. Standard tolerance ±1%; also ±½, ¼, 1/10 and 1/20% tolerances can be supplied. Tru-Mite core material is the same epoxy resin as is used for the embediment. This eliminates the normal effects of temperature and moisture. Tru-Mite resistors exceed MIL-R-93A specifications.

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For Super-Rugged Service (Shocks to 250G) . . . Varian offers the VA-201 klystron. This tube is equipped with integral molded silastic leads, is similar to the VA-203 and performs with the same absolute reliability.

All these exclusive Varian features . . .

- ★ **Unique brazed-on external tuning cavity assures exceptional frequency stability.**
- ★ Reliable operation at low voltage and from poorly regulated power supplies.
- ★ Negligible microphonics.
- ★ Slow tuning rate . . . long tuning life . . . single shaft tuner adapts easily to motor tuning.
- ★ Withstands 50 to 100 G shocks (up to 250 G's for the VA-201)
- ★ VA-203 weighs less than 4 ounces. Both tubes mate directly to standard waveguide flanges.

GUARANTEED SPECIFICATIONS		
8500 to 9600 mc	VA-203	VA-201
Resonator Voltage	300 V	250 V
Heater Voltage	6.3 V	6.3 V
Heater Current	0.45 Amp	1.2 Amp
Power Output	20mW, Min	15mW, Min
Electronic Tuning Range	30 Mc, Min	30 Mc, Min
Vibration FM at 10 G	1 Mc, p-p, Max	0.2 Mc, p-p, Max

GET COMPLETE TECHNICAL DATA and specifications on the outstanding new VA-203 and its companion VA-201 . . . finest klystrons made for airborne radar. Write to our Applications Engineering Department today.

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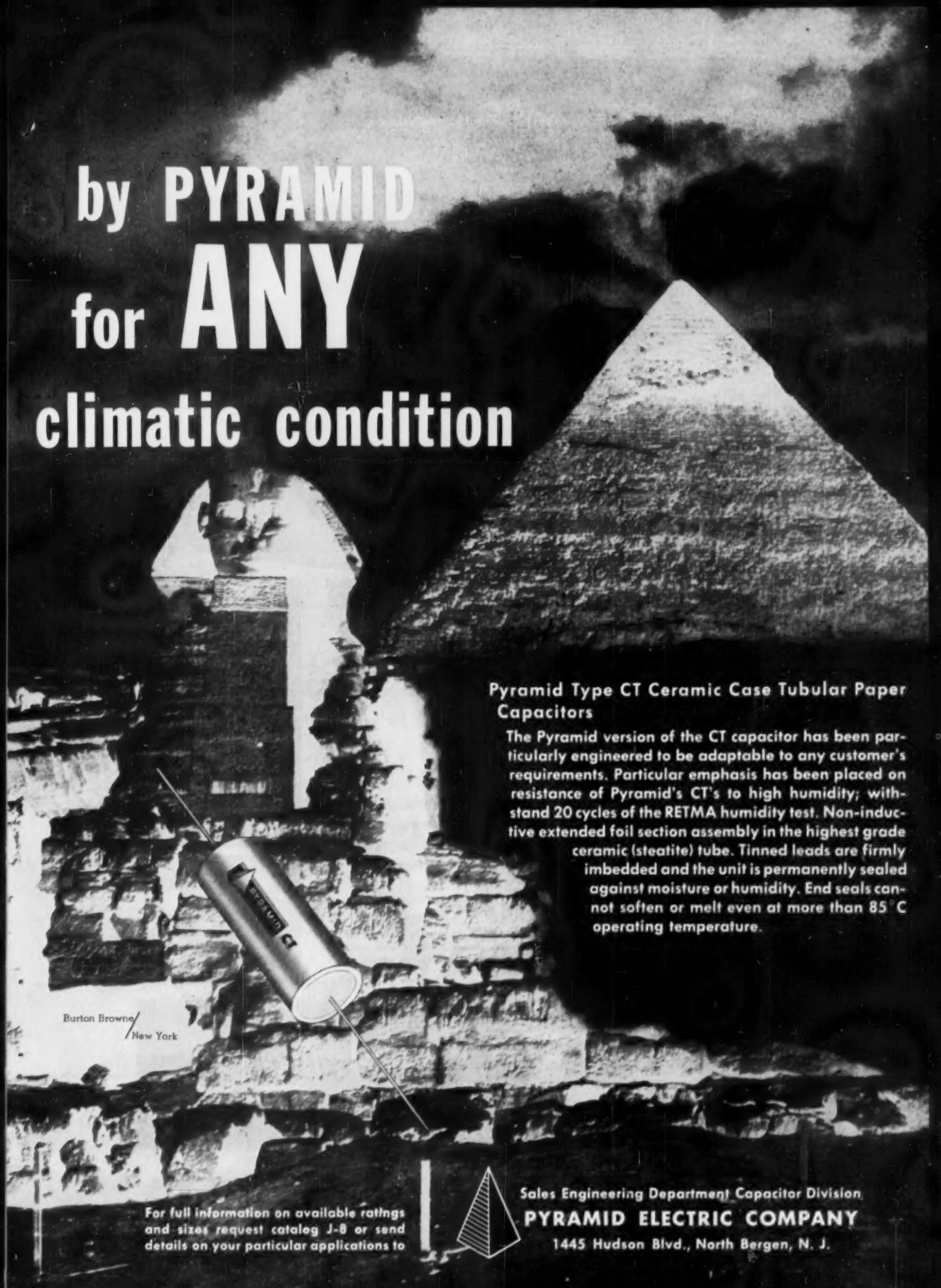

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The Pyramid version of the CT capacitor has been particularly engineered to be adaptable to any customer's requirements. Particular emphasis has been placed on resistance of Pyramid's CT's to high humidity; withstand 20 cycles of the RETMA humidity test. Non-inductive extended foil section assembly in the highest grade ceramic (steatite) tube. Tinned leads are firmly imbedded and the unit is permanently sealed against moisture or humidity. End seals cannot soften or melt even at more than 85° C operating temperature.

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C - AT 1 OR 10 kc

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INDUCTANCE, CAPACITANCE, RESISTANCE and power factor measured quickly and accurately on this self-contained and robust instrument. Its industrial-designed appearance fits well in modern surroundings and partners its outstanding electrical performance.

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Inductance from 1 μH to 100H, Capacitance from 1 $\mu\mu$F to 100 μF, and Resistance from 0.1 Ω to 10M Ω.

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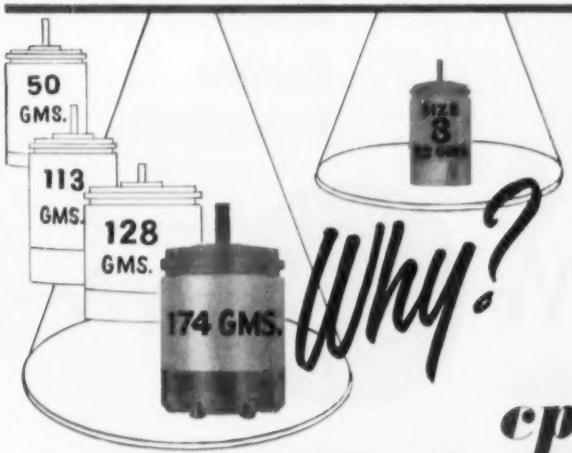
CLIFTON PRECISION'S NEW 8 SIZE SYNCHROS

Function	Type Number	Primary Element	Excitation Voltage 400 cy.	Input Current (ma.)	Input Power (Watts)	Primary Impedance Secondary Open (Phase)	Primary Resistance (Rnn)	Secondary Element	Output Voltage	Secondary Impedance Primary Open (Phase)	Secondary Impedance Primary Shorted	Secondary Resistance (Rnn)	Phase Shift Degrees	Sensitivity mv./deg.	Accuracy Minutes Max.
Transmitter	CGC-8-A-7	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.230	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.091	67+ j270	59.5	Rotor 1 Phase	24	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.268	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26	39	.430	280+ j600	230	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	30' *
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36	9	200	7 Rotor 7 Stator

Total Null max. 20mv for each unit

*Torque 2600 mg.-mm. degree from CGC-8-A-7

Also available in 115v 400 cy. primary, 90v secondary Transmitters, C.T.'s, Receivers



WHY USE 1945 SYNCHROS IN 1956 DESIGNS?

Clifton's new Size 8's can take the place of larger units at very significant saving in bulk and *weight*.

These new Size 8's are now in use in some of the latest and *lightest* avionic equipment. In equipment which must be flown, why load on extra weight?

Samples are available from stock, quantities from the production line.

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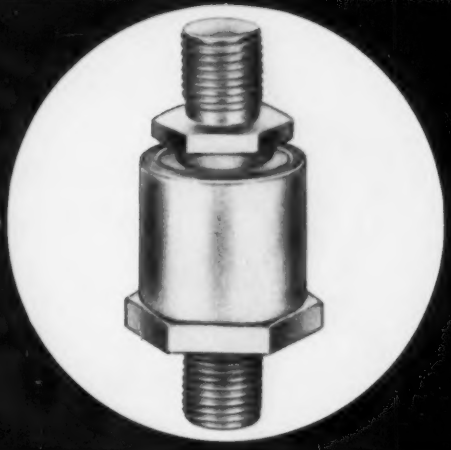

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CAPACITORS

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Three separate lines of G-E tantalum electrolytic capacitors to meet your size and temperature needs

No matter what capacitor problems you face in your most critical electronic applications, you're almost sure to find an answer in the three proven lines of Tantalytic capacitors now offered by General Electric.

Is size your problem? G-E Tantalytic capacitors carry extremely high uf ratings per cubic centimeter, especially in the 0-150 VDC range. In some ratings, Tantalytic capacitors are actually less than 1% the size of comparably rated paper capacitors.

Is high reliability your problem? Where small size and high reliability are "musts," as they are in communications equipment for example, G-E Tantalytic capacitors meet the challenge. Their high quality assures long, more reliable operation — at a real saving in circuit space.

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General Electric engineers have accumulated a wealth of life test and other data through a long period of testing tantalum capacitors under every conceivable condition of operation. As a result, G-E Tantalytic capacitors may be relied upon for mechanical and electrical stability and maximum efficiency in operation.

Let your G-E Apparatus Sales Representative show you how these capacitors can answer your particular problems. Or, if you would like further information (ratings and specifications) on G-E Tantalytic capacitors write directly to the General Electric Company, Section 442-30, Schenectady 5, N. Y.

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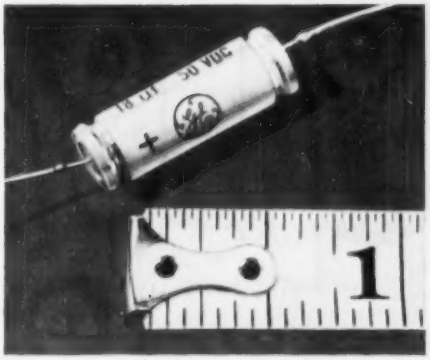
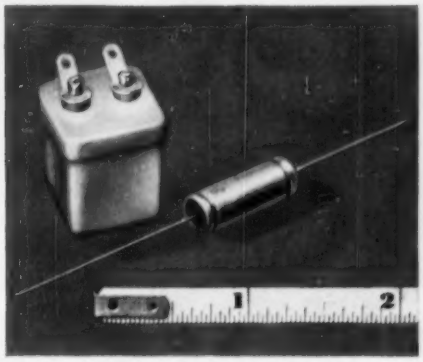
Progress Is Our Most Important Product

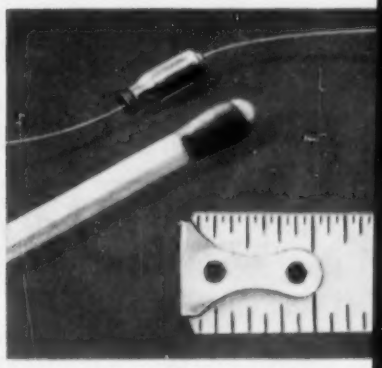
GENERAL ELECTRIC



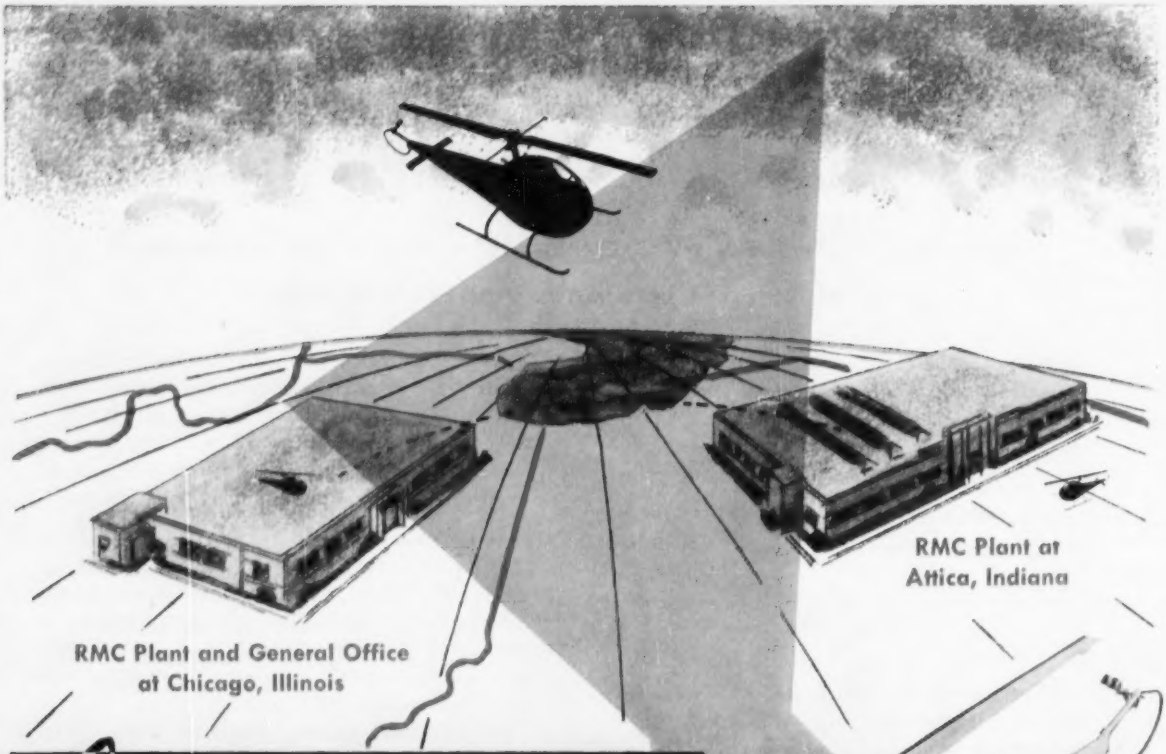
85 C TANTALYTIC CAPACITORS for circuits requiring low leakage current, long shelf life. Available in polar or non-polar types for a-c and d-c. Ratings 0.25–580 uf, 3.75–150 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +85 C. Write for Bulletins GEC-808 and GET-2333.



125 C TANTALYTIC CAPACITORS for high-speed aircraft and guided missile electronic systems where quality, long life, small size are main requirements. Available in plain or etched foil, in rectangular or tubular designs. Ratings 0.25–180 uf, 10–100 v. Tol. ±20% (plain foil), −15 to +75% (etched). Temp. range −55 to +125 C. Write for Bulletins GEA-6258, GET-2502, and GET-2513.



MICRO-MINIATURE TANTALYTIC capacitors for low-voltage d-c, transistorized electronic equipment such as hearing aids, pocket radios. Ratings 1–8 uf at 4 VDC, 1 uf at 8 VDC, 0.5 uf at 16 VDC. Tolerance −0 to +200%. Temperature range −20 to +50 C. Bulletins GEA-6065 and GET-2405.



Another RMC First!

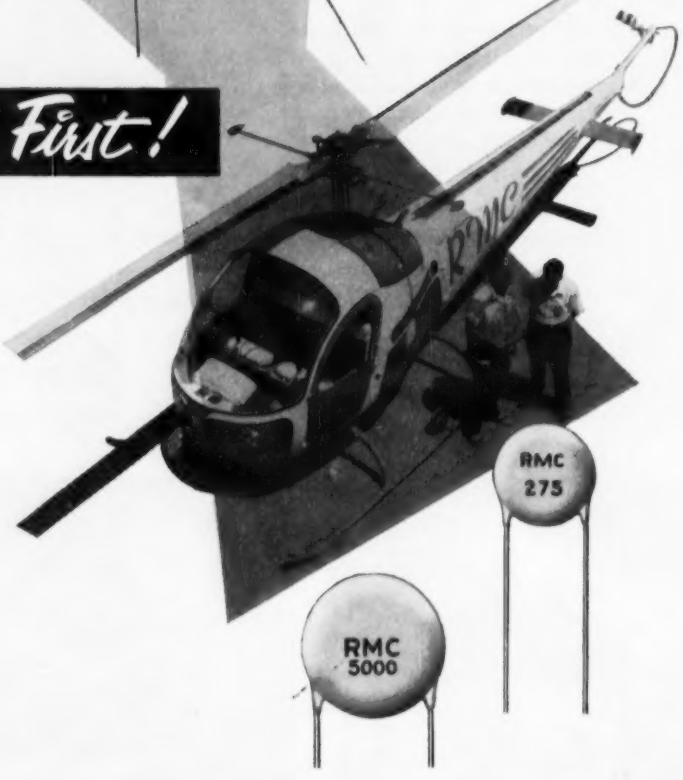
Plant to Plant Helicopter Service

The tempo of RMC service has always been geared to the needs of important customer production schedules. Now RMC's modern manufacturing facilities at Chicago, Illinois and Attica, Indiana are provided with fast, dependable helicopter flights, enabling executive and engineering personnel to travel door to door in slightly more than one hour as compared to a previous four hours.

The new Bell 47H helicopter makes regular flights unhampered by weather and traffic. RMC is the first in the electronics industry to use this new mode of travel.

Now you, as an RMC customer, are assured of even faster service on your production and engineering requirements.

If you are now using any type of ceramic capacitor in the manufacture of your products, it will pay you to investigate DISCAPS...and the many other advantages offered by RMC.



DISCAP
CERAMIC
CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

you can't match TRIPLETT *model 630 VOM*

for SPEED ACCURACY DURABILITY CONVENIENCE!

heavy molded case

—¼" thick for high impact. Fully insulated.

sure grip battery contacts

Balanced double-spring tension grip assures permanent contact.

"this wide-range model

tests AC-DC Volts (DC at 20,000 O/V); DC Microamperes, Milliamperes, and Amperes; Ohms (to 100 Megohms); Decibel and Output. Its easy-to-read scales are the longest in this type tester."

streamlined design

No protruding knobs on switch or ohms control—both are flush with the panel.

king size recessed knob

—Only one switch; (fully enclosed) selects both circuit and range. Just turn the switch and make your reading.

for quick positive connections

—Banana jacks and plugs on test leads are best. Alligator clips are provided to slip on test prods for extra convenience.

for most efficient meter use

—With every Model 630 you receive complete, simplified instructions on how to use and maintain most efficiently.

advanced engineering

—Molded mounting for resistors and shunts allow direct connections without cabling. No chance for shorts. Longer life and easy-to-replace resistors in their marked positions.

for convenience in reading

—Available as an extra (only 50c), this special stand tilts meter at best angle for easy reading

no slip feature

Four rubber feet furnished as standard equipment fit in back of the case to prevent slipping on smooth surfaces.

MODEL 630 | $39.50

TRIPLETT ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio

THE MIGHTY NINE VOM LINE

631	630-NA	630	630-A	310	630-T	666-HH	625-NA	666-R
Combination V-O-M—VTVM	For Best Testing Around The Lab, Production Line or Bench	The Popular All-Purpose V-O-M	A Good Lab and Production Line V-O-M	The Smallest Complete V-O-M With Switch	For Telephone Service	Medium Size For Field Testing	The First V-O-M With 10,000 Ohms/Volt AC	Medium Size With 630 Features

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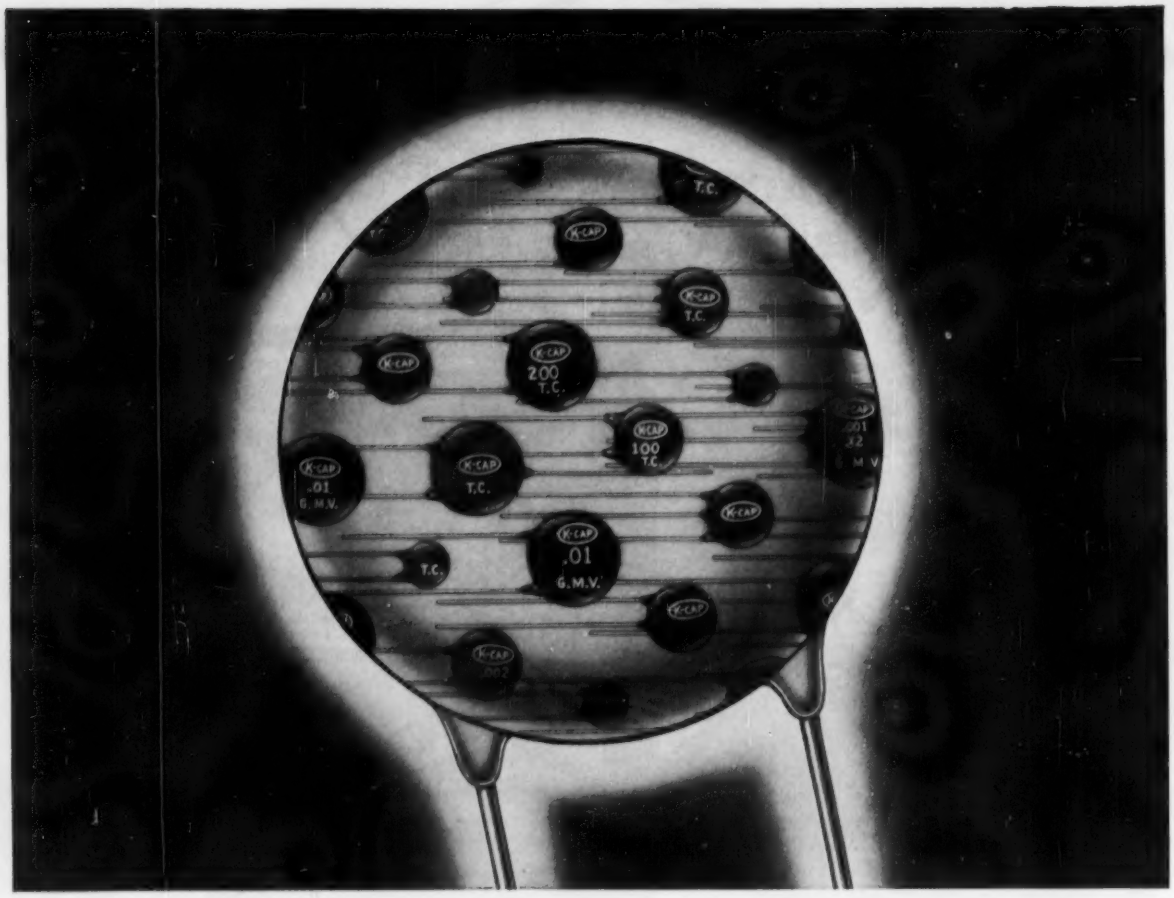

Did you know that only AUTOMATIC *makes K-CAP Ceramic Disc Capacitors?*

K-CAP* Ceramic Disc Capacitors are another mass produced electronic product made by Automatic Manufacturing Corporation, originators of the famous K-Tran* and J-Tran* I.F. Transformers...the first standardized I.F.'s in the industry.

K-Cap capacitors, like K-Tran and J-Tran, are manufactured completely within our own plant from the basic powders to the completed capacitor. The high K ceramic bodies are developed in our own modern laboratory and produced under the exacting supervision of our quality control engineers. The silvering process is done by men with more than 20 years experience in silvering trimmers and condensers.

K-Cap Ceramic Capacitors are distinguished by their black, wax impregnated, phenolic coating, stamped with red markings. All bear the registered trade mark K-Cap.

They are made in 4 standard types:

GUARANTEED MINIMUM VALUE
for bypassing, etc.

GENERAL PURPOSE
for coupling, etc.

TEMPERATURE COMPENSATED
in a range of T.C. from N.P.O. through N2200

HIGH STABILITY
for elimination of drift

Available in either single capacitor, dual capacitor unshielded, and dual capacitor shielded, in a range from 2. uuf to .02 uf.

☆ ☆ ☆

For more information about K-Cap, K-Tran and J-Tran, write for a copy of the K-Tran–K-Cap Manual–56 pages of engineering information, most valuable to you in Electronic designing.

Every part Automatic uses ... Automatic makes.

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MASS PRODUCERS OF ELECTRONIC COMPONENTS

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Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons

VOLTAGE TUNABLE

1,000 mc. ⟵ ⟶ 16,000 mc.

QK518 specifications

Frequency: 2,000-4,000 mcs.

Rapid electronic tuning by varying delay line voltage from 150-1,500 Volts.

Power output: 0.1 to 1 watt

Complete with compact permanent magnet

Approximate maximum dimensions: 10" long, 4⅜" high, 4⅞" wide.

NEW Raytheon Backward Wave Oscillator Series

for wide, rapid electronic tuning – 1,000 mc. to 16,000 mc.

The tubes in this revolutionary new line of Raytheon Backward Wave Oscillators give you four outstanding performance advantages:

1. Electronically tunable over an *extremely* wide range of frequencies
2. Frequency insensitive to load variations
3. High signal-to-noise ratio
4. Can be operated under conditions of amplitude or pulse modulation

These new tubes are finding fast-growing applications in microwave equipment, including radar and signal generators.

Write today for free Data Booklet on the QK518 (above) which is available for delivery. We'll also be happy to answer any questions you may have on this new line.

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Excellence in Electronics

Raytheon Makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Transistors

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KOCH ...*World's largest fabricator of moulded Fiberglas products*

How Convair 340's Solve a Housing Problem for United Air Lines' All-Weather Radar

The nose knows when and where bad flight weather threatens! Radar weather-spotting equipment in the nose of United's Convair 340 now sees through a Koch Fiberglas Radome.

When Convair received United's order for radar-equipped 340's, they naturally turned to Koch, world's largest fabricator of moulded Fiberglas, for domes to house the radar.

The life expectancy of the Koch Radome is many, many times that of any other Radome. This Radome is made possible only by Koch's own exclusive method of moulding.

W. J. Flanagan, Convair Purchasing Agent, wrote Koch upon completion, "You have made substantial contributions to this industry by proposing and successfully applying new departures and moulding technique."

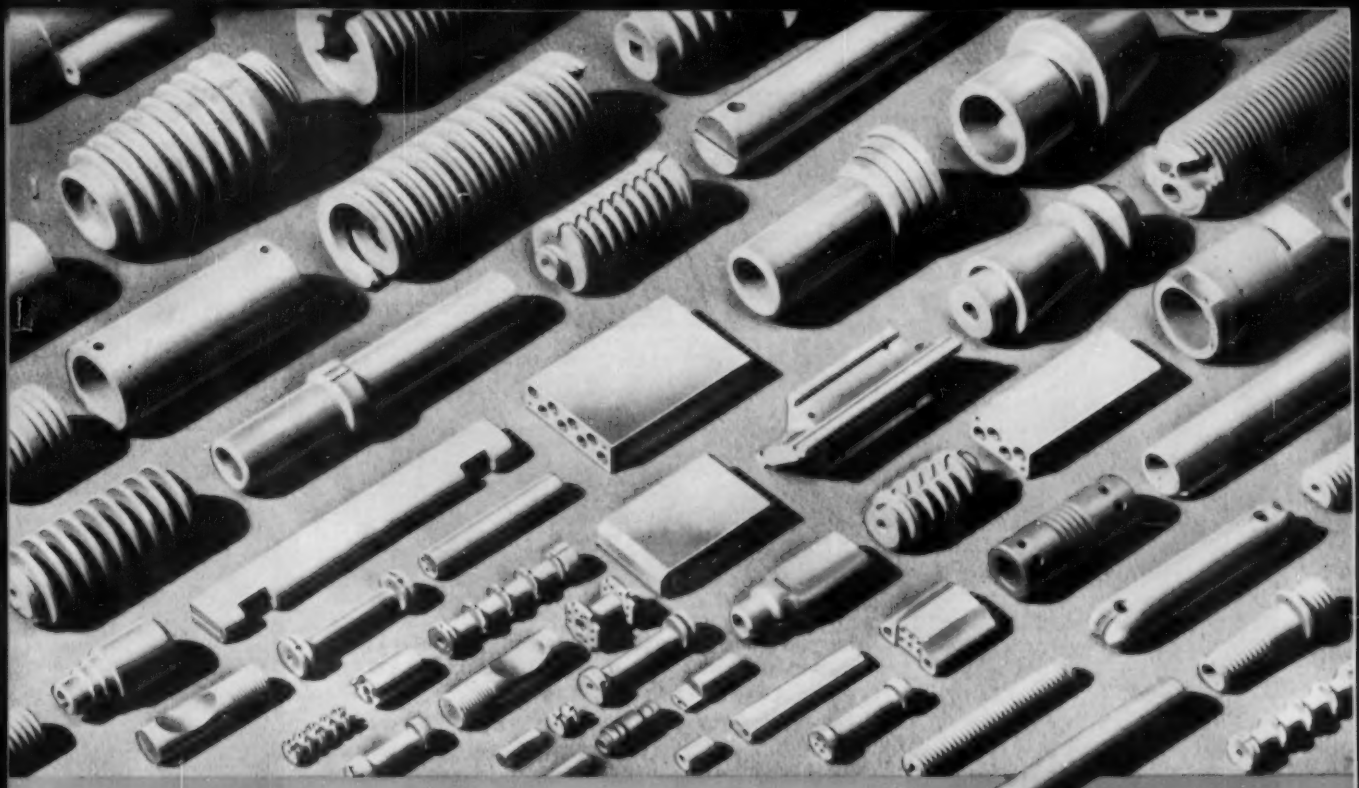
If you are a plane manufacturer, or if you install airborne radar, investigate Koch's Moulded Fiberglas Radome. If you manufacture any equipment that needs special protection, ask the people who know the most about Fiberglas fabrication. We will be glad to confer with you about your project. Address Dept. EKE.

KOCH *Fiberglas*

PRONOUNCED "KOKE"

Pioneer in industrial products of moulded Fiberglas

CORTE MADERA, CALIFORNIA



ALSIMAG® EXTRUSIONS

speed production.....

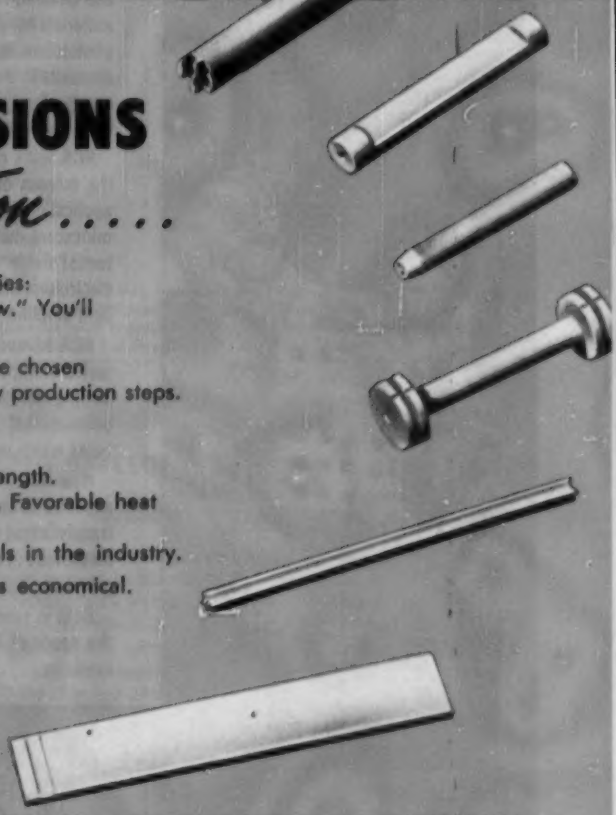
FASTER DELIVERY. Four things are vital to quick ceramic deliveries: Plenty of Materials, Machinery, Firing Facilities and "Know How." You'll find all four in greater abundance where AlSiMag is made.

SIMPLIFIED ASSEMBLY. Versatile AlSiMag extrusions can often be chosen or designed to combine several functions, thus eliminating costly production steps. Wider range of shapes, sizes and cross sections.

HIGHER QUALITY. Uniformity and precision tolerances make AlSiMag extrusions easy to assemble. Other "plus" factors: Strength. Permanent rigidity. Resistance to chipping. Corrosion resistance. Favorable heat shock characteristics. Superior performance at higher temperatures and higher frequencies. Widest choice of materials in the industry.

LOWER COSTS. Ceramic production by the extrusion method is economical. Since basic extruded shapes can be machined before firing, extremely intricate as well as simple designs can be produced rapidly at prices favorable to production budgets.

AlSiMag Extrusions May Solve Your Problems!
Send us a blueprint or sketch for full details.



54TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

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A Subsidiary of
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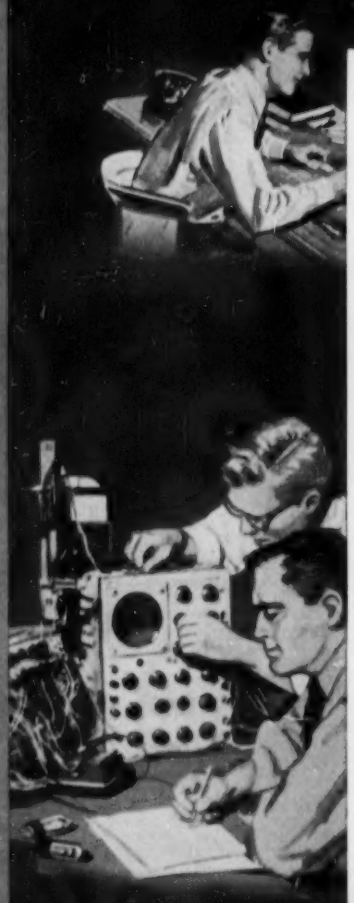
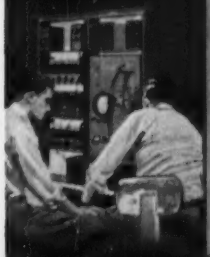
RCA DATA FOR

SOLID-STATE ELECTRONICS . . . AT RCA





For many years the Radio Corporation of America has been actively engaged in a broad program of research, development, and production of solid-state materials and devices.

Many of the electronically active solids under study and development at RCA have opened or are opening the way for new products and circuits. For example, photo-emissive and secondary-emissive materials have made possible the Image Orthicon and the multiplier phototubes. Photoconductive materials are used as light-sensitive elements in the compact Vidicon camera tube; and in new developments, they are making possible sensitive photoconductive cells for a host of potential applications.

RCA work on cathodoluminescent materials so widely used for the screens of cathode-ray tubes is being extended to find new applications for these materials; in addition, the newer electroluminescent materials are also being investigated to determine potential fields of application. By combining photoconductive and electroluminescent materials, RCA Laboratories are developing the light amplifier for intensifying images.

RCA advances in the understanding of semiconductors have resulted in important improvements in transistors. In addition to its commercial line of precision-made transistors and germanium point-contact crystal diodes, RCA has under development other types which will open new avenues of circuit design.

New ferromagnetic and ferroelectric materials under study are expected to facilitate the construction of miniature components for transistorized equipment . . . for electronic computers and business machines . . . and for many other applications symbolic of electronic progress.

Both in research and production, RCA is geared to contribute to the needs of industry for new and better products for expanding markets.

RCA DISTRICT OFFICES

East: HUmboldt 5-3900
744 Broad Street,
Newark 1, N. J.

Midwest: WHitehall 4-2900
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Merchandise Mart Plaza,
Chicago 54, Ill.

West: RAymond 3-8361
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DESIGNERS

ELECTRON TUBES
SEMICONDUCTOR DEVICES
BATTERIES
TEST EQUIPMENT
ELECTRONIC COMPONENTS

RCA TRANSISTORS FOR AF APPLICATIONS

RCA-2N77— for low-power af applications.

RCA-2N104— for low-power af service in communications and general electronic equipment.

RCA-2N109—for large-signal audio applications, such as in class B p-p power output stages of battery-operated portable radios operating at power levels of approx. 160 milliwatts.

RCA-2N105— for low-power af applications in apparatus where extremely small size is required.

RCA Transistors listed below are germanium, p-n-p, alloy-junction, hermetically sealed types, in insulated metal jackets. These high-quality transistors are designed specifically for applications where extreme stability and exceptional uniformity of characteristics are paramount—initially and throughout life—and for circuits where very low collector cutoff current is essential. In addition to the units described here, RCA is developing new transistor types which will broaden transistorization of electronic equipment.

	RCA-2N77	RCA-2N104	RCA-2N105	RCA-2N109
MAX. RATINGS (Absolute Values):				
Collector Volts	−25	−30	−25	−25
Collector Ma	−15	−50	−15	−70
Collector Dissip. (mw)	35	up to 150*	35	50
Operating Temperature (°C)	50	70	50	50
TYPICAL OPERATION:†				
Collector Volts	−4	−6	−4	−9
Collector Ma	−0.7	−1	−0.7	−13
Alpha (Collector-to-base connection)	−55	−44	−55	70††
Power Gain (db)	44	41	42	33**
Power Output (mw) Approx.	—	—	—	160**
Source Imped. (ohms)	1980	1400	2300	375 per base connection
Load Imped. (ohms)	100,000	20,000	20,000	200 per collector
Noise Factor (db)	6.5 av.	12 max.	4.5 av.	—
Cutoff Freq. (Kc)	700	700	750	—
Figure of Merit for High Frequency Performance (Mc)	1.7	1.6	2.6	—

* Depends on temperature and circuit parameters †† Large-Signal
† In common-emitter circuit at ambient temperature of 25° C.
** For 2 transistors in class B of circuit; distortion of less than 10 percent

NEW SOLID-STATE DEVICES UNDER DEVELOPMENT

Ferrites

RCA has an extensive background of more than 5 years in the design, development, and manufacture of ferrites. Under development for a great diversity of electronic applications are the following four categories of ferrites:

1. Hard—displaying a large hysteresis loop, as in permanent magnets; 2. Soft—having small hysteresis losses, as required in deflection-component cores and high-frequency transformers; 3. Square Loop—with "square" hysteresis loops, as used in computer memory devices and high-speed switching circuits; 4. Magnetostrictive—exhibiting change in physical dimensions when placed in a magnetic field, as in transducers.

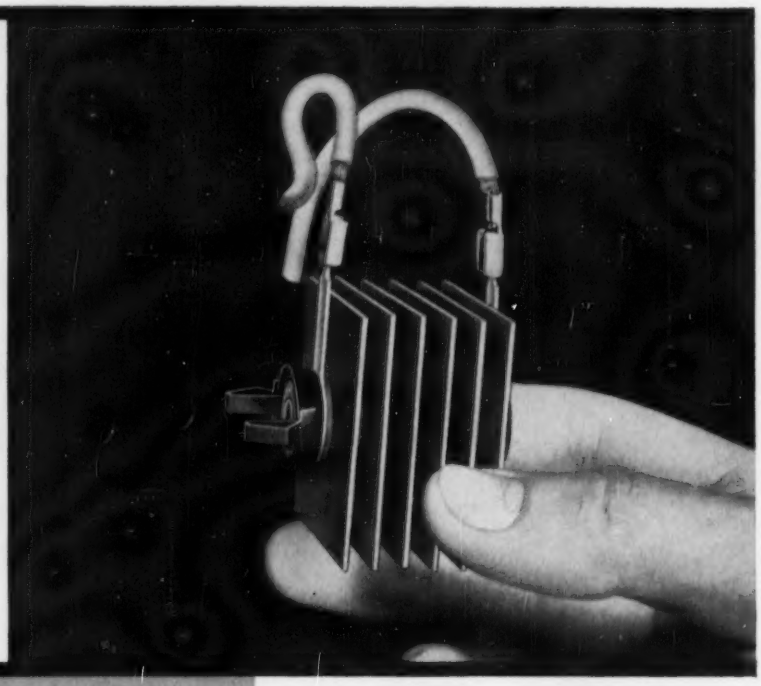
Semiconductor Photocells

RCA's many years of experience in solid-state electronics serves as excellent background for its developmental programs in semiconductor photocells. When such cells become commercially available, it is expected that they will find application in street-lighting control, headlight-dimming control, animated-sign control, computer and business-machine reading devices, and other light-actuated devices.

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

Want more information? Use post card on last page.

Radio Receptor's NEW money saving rectifier mounting!



"QUI-KLIP" *snap-in type* SELENIUM RECTIFIERS

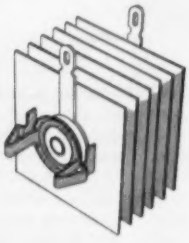
QUICK MOUNTING! QUICK REMOVAL!

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx ¾" dia., ¾" c. to c.). Solderless connectors as shown, when used, simplify servicing

Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier – no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. E-13.



- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.

Really RR Reliable

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

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SELENIUM RECTIFIERS, THERMATRON DIELECTRIC HEATING GENERATORS AND PRESSES, COMMUNICATION, RADAR AND NAVIGATION EQUIPMENT

NJE

MEMO

FROM: The Custom Engineering Staff at NJE

TO: Engineers and Purchasing Agents who buy power supplies

SUBJECT: **The $64 ANSWER**

Our weekly mail never contains fewer than 35 requests for quotation on non-standard power supplies.

Some of these requests can be handled by modification of standard supplies, but most of them require a custom unit.

When we say "custom" we mean it in the fullest sense of the word -- custom design, custom construction, custom test...but first (and most important) of all -- custom specification.

A complete regulated power supply specification contains at least fifty* facts about the equipment it describes.

We don't ask our customers to be that complete, because we've become very good at long-distance mind-reading. Just give us a good start, describing the application if possible. We'll give your request the "full treatment".

If you need expert advice in formulating your specification, call in one of our local engineering representatives. He can show you copies of hundreds of different custom quotes we have made recently, from $65 to $180,000. If you wish, he will write up the specification for you, and transmit it to us for quick action.

INCIDENTALLY—

The average quote takes 7½ man-hours of design, pricing, soul-searching, and just plain crystal-gazing. It takes secretarial time, paper, postage, and something called overhead. It costs us, according to our accountant (who *never* crystal-gazes), exactly $67... but who ever heard of a $67 answer? So we called this memo the *$64 answer*. Need one? Write, wire, phone.

*

Hard to believe? Not when you start adding them up. For example, here are some of the most important!

- Input voltage range
- Input current
- Input power
- Input power factor
- MIL Spec conformation
- Output voltage range
- Output current range
- Regulation—static
- Regulation—dynamic
- Response time
- Output Impedance—DC
- Output Impedance—dynamic
- Ripple and Noise
- Stability
- Circuit Protection (fusing, etc.)
- Personnel Protection (interlocks, etc.)
- Meters (accuracy, size, etc.)
- Housing
- Size
- Weight
- Price
- Delivery

For our complete line of electronic power supplies See electronics Pg. 113-120 BUYERS' GUIDE

Write for Catalog Z-5

NJE corporation

Electronic Development & Manufacturing

New Phone No. Chestnut 1-1500

345 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY

Competent Engineering Representation Everywhere | Rapid, complete, competitive custom quotes from 1000 Amperes (low voltage) to 250 KV (low current.)

POWER SUPPLIES UNLIMITED

MALLORY

New 1700 series Mallory split-reed vibrator uses special alloy leaves which serve both as contacts and as springs . . . eliminating usual button contacts. Life is greatly increased, constancy of output improved, and driving power reduced.*

*Patent Applied For

New Heavy Duty Mallory Vibrator

gives far longer life, constant output

For the peak in dependability and performance, plan to use this newest Mallory vibrator in your communications equipment. A completely new idea in vibrator design eliminates conventional contact buttons. The spring leaves themselves . . . made of special contact alloy . . . act as contacting members. This design provides greatly increased contact area, with these important advantages:

Consistently Longer Life. Tests made on heavy duty cycles prove up to 100% greater service can be expected . . . with a high degree of consistency.

Steadier Output. The decreased rate of erosion means less change in contact spacing, less variation in voltage.

Flare-Proof Starting. The new low-mass design permits wider contact spacing to prevent start-up flare . . . without need for greater driving power.

Exceptional Uniformity of characteristics is made possible by the simplified design.

Minimum Size for heavy duty ratings.

The new design is available in the split-reed type shown here, for 6/12 volt service, and in the Duplex heavy duty model without the split reed construction. For full technical data, and for a consultation on your specific power supply requirements, write or call Mallory.

COMPLETE POWER SUPPLIES

It may be that you can save time and reduce over-all costs by employing a complete Mallory Vibrapack® power supply. Vibrapacks can be engineered around the new heavy-duty 1700 series vibrator to give long, reliable service. Design includes precise balancing of critical components. Normal ratings are conservative. Compact-sized Vibrapacks fit readily into crowded layouts. For further information, advise Mallory of your specific requirements.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
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electronics

W. W. MacDONALD, Editor

DECEMBER • 1955

CROSS TALK

►**CONVERSATIONAL SERVICE** . . . Following up last month's editorial entitled D.O.A., we call attention to a particular kind of repair work that often goes hand in hand with skimped products.

The essential tool is the tongue rather than the test set. From the tip of this instrument, firmly embedded in cheek, rolls such phrases as "They all work that way in this neighborhood," or "That's the way it's supposed to work," or "I don't see nuthin' wrong with it," or "There, that's a little better."

Much of this goes back to the fact that a man cant fix what isn't there. And so we repeat: There should be more design margin . . . *and men with a conscience.* More rugged assembly . . . *and men with a conscience.* More careful adjustment . . . *and men with a conscience.* More critical testing . . . *and men with a conscience.*

People are getting tired of being talked out of it.

►**SEGREGATION** . . . Because the electronics industry continues to grow and diversify, it is inevitable that from time to time someone will suggest further grouping of like exhibits at trade shows. Component parts would all be together in one area, instruments in another, transmitters in another, industrial controls in another and so on. This would permit highly specialized technicians to concentrate upon areas containing products of obvious immediate interest, therefore the suggestion has some merit.

Similar segregation of printed pages has several times been suggested to ELECTRONICS magazine. We have weighed the pros and cons, and continue to resist because ideas generated in one branch of this business have a habit of solving problems in other branches. Anything tending to reduce the exposure of the audience to overall technical advances would reduce the idea carryover.

We think, too, that while segregation might be neat it also could be deadly dull.

►**PORTICO** . . . Speaking of shows, we were intrigued enroute to the huge WESCON meeting in San Francisco by a program note that said exhibits would be in the Civic Auditorium and an adjacent *portico.*

Were it not for the fact that our dictionary says a portico is "a structure consisting of a roof supported by columns or piers," and the absence of tanbark on the ground, we would have sworn it was a tent.

►**BOUNCE** . . . You can knock a New Englander down but it is hard to knock him out. A manufacturer in the flooded northeast fished some equipment out of the drink the other day and noted that several panel meters were filled with water. "That," he remarked," is what I call optimum damping."

LOOKING AHEAD . . .

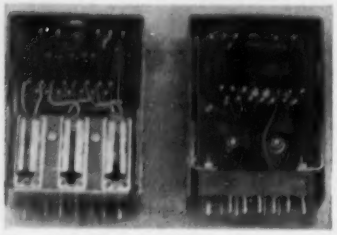
Transistor production techniques quite different from those currently in use are well along in an advanced laboratory stage, may late next year radically reduce waste, cut costs, expand applications

Earth's magnetic field can displace a tv picture a fraction of an inch when a set is moved. Not noticeable with monochrome, but suggests need for easily accessible adjustment when dealing with color

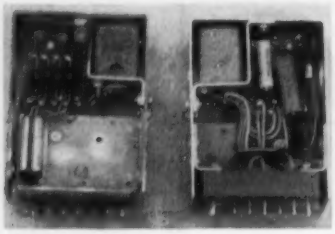
Watch for announcement of less complex color tube shadow mask, expected momentarily

Machines that type words instead of letters of the alphabet are already in experimental use. Next step will be broadening of vocabulary by means of magnetic storage. Ultimate may be typewriter you just talk to

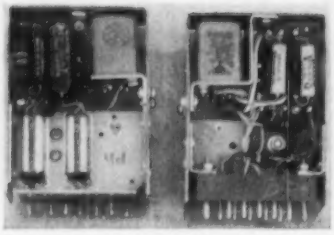
Industrial process control is simplified when . . .



Operational d-c amplifier



Modulator



Demodulator

Basic Control Circuits

SUMMARY —— These basic circuits will solve more than 75 percent of an industrial control engineer's electronic problems. When the circuits are built up in plug-in form and stocked, relatively complex systems can be assembled off-the-shelf

AUTOMATIC CONTROL in industry requires many mechanical, electromechanical and electronic subassemblies. To develop a new control system, it would be desirable to have an on-the-shelf stockpile of building blocks to perform the various functions required.

Development time could be reduced considerably. All that would be required would be to connect these building blocks to satisfy the specified requirements. There will always be a few specialized items in each system that must be developed to satisfy a particular need. However, these cases represent only 10 to 15 percent of the total system.

Circuits Required

Amplifiers, power supplies, modulators and demodulators represent over 75 percent of the units required for an automatic control system.

The specifications for an amplifier, modulator or demodulator should include: gain, frequency response, phase shift, drift stability, linearity, input, output and load impedance, maximum linear voltage output swing, output voltage with zero input voltage and power.

The specifications for a power supply should include: nominal output voltage, output current range, load-change and line-change regulation, output impedance and power.

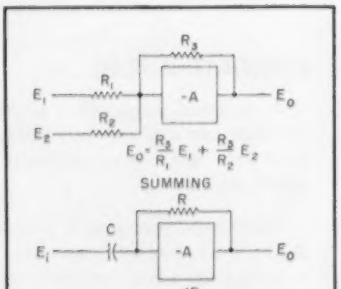


FIG. 1—Operational amplifiers sum, differentiate and integrate

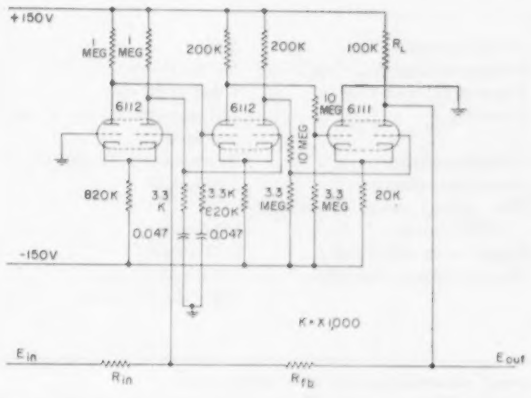
D-C Amplifier

There are as many types of amplifiers as there are electronic engineers. However, the most versatile type of amplifier may be used for adding, subtracting, integrating or differentiating. This amplifier is usually direct coupled as found in analog computers. But it may be an a-c amplifier if only addition or subtraction is required and extreme simplicity as well as long-time high-gain drift stability are desirable.

The theory of operational amplifiers is available in many textbooks.[1]

Figure 1 illustrates the basic operations that may be performed by operational amplifiers. Figure 2 is the schematic for a d-c operational amplifier with the specifications listed in the accompanying table.

Closed-loop gain may be adjusted by varying the ratio R_{f1}/R_{in}. The values of the cathode resistor and



Open-loop gain	4,500
Frequency response	
open loop	3 db down at 50 cps
closed loop (R_{fb}/R_{in}) = 10	3 db down at 50,000 cps
Phase shift	
open loop	135 deg at 50 cps
closed loop (R_{fb}/R_{in}) = 10	135 deg at 50,000 cps
Drift	20 mv referred to input grid
Gain linearity (R_{fb}/R_{in}) = 10	0.22 percent
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	
open loop	33,000 ohms
closed loop (R_{fb}/R_{in}) = 10	73 ohms
Optimum load impedance	greater than 10,000 ohms
Max output swing	
(50,000-ohm load)	±50 v

FIG. 2—Circuit and specifications for a d-c operational amplifier such as used in analog computers

Are Packaged

By L. S. KLIVANS*
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R_L at the output are a function of the load impedance and the maximum desired output voltage swing. A plug-in version of this amplifier is shown in a photograph.

A-C Amplifier

Figure 3 is a schematic of an a-c operational amplifier with the specifications listed in the table.

Closed-loop gain may be adjusted by varying the ratio R_{fb}/R_{in}. The values of R_b and R_L at the output are a function of the load impedance and the maximum desired linear output voltage swing.

Servo Amplifier

Figure 4 is a schematic of a 60 or 400-cps servo amplifier. Although both of the operational amplifiers can be used also as servo amplifiers if a large number of inputs and low gain as well as power output is required, in general this is not the case. For simplicity, as well as increased performance, it is desirable to have a servo amplifier building block.

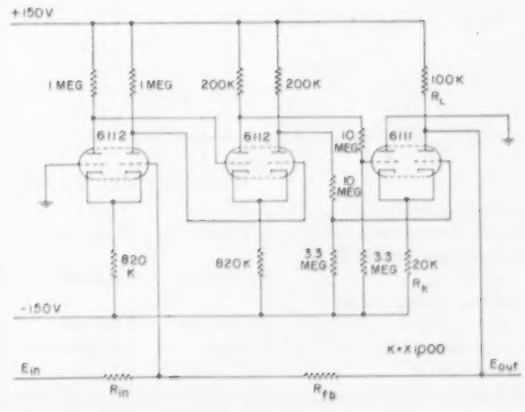
Servo amplifier gain may be adjusted by varying the ratio R_{fb}/R_{in}.

The output transformer is chosen to match load impedance characteristics. It was selected to drive a Transicoil 11MG 400-cycle induction motor-generator.

Power Supplies

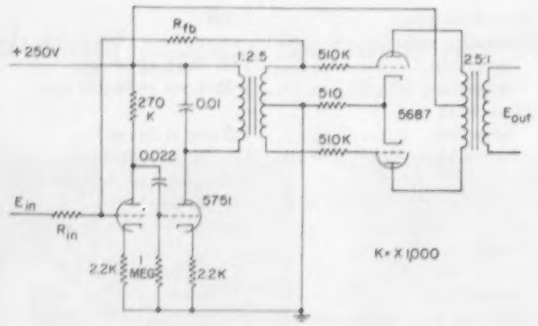
A series-regulated power supply package is excellent for the 0.5 to 1-

* Now with Radioplane Co., Van Nuys, California.



Open-loop gain	4,500
Frequency response	
open loop	3 db down at 4,000 cps
closed loop (R_{fb}/R_{in}) = 10	3 db down at 40,000 cps
Phase shift	
open loop	135 deg at 5,000 cps
closed loop (R_{fb}/R_{in}) = 10	135 deg at 24,000 cps
Gain linearity (R_{fb}/R_{in}) = 10	0.22 percent
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	
open loop	33,000 ohms
closed loop (R_{fb}/R_{in}) = 10	73 ohms
Optimum load impedance	greater than 10,000 ohms
Max output swing	
(50,000-ohm load)	30 v rms
Output with zero input	30 mv rms

FIG. 3—Long-time high-gain drift stability characterizes this a-c operational amplifier



Open-loop gain	2,100
Frequency response, open loop	flat to 20 cps
Phase shift, open loop	0 deg at 20 cps
Linearity	±5 percent to 80 v rms output
Input impedance	dependent on R_{in} and R_{fb}
Output impedance	5,000 ohms
Max output swing (Transicoil 11MG motor)	110 v rms
Output with zero input	0.85 v rms
Max power requirements	6.3 v at 1.25 amp 250 v d-c at 25 ma

FIG. 4—Servo amplifier for 60 or 400 cps features simplicity and increased performance over operational types

percent regulation range. Where 2 to 5-percent regulation is satisfactory, simplicity may be gained by utilizing voltage-regulator tubes. The latter category is suitable for servo amplifiers. The former is recommended for operational amplifiers to insure long-time drift stability.

Figure 5A is a schematic of a subminiature plug-in series-regulated power supply utilized with the operational amplifiers shown in Fig. 2 and 3.

Figure 5B shows a regulated power supply utilizing voltage-regulator tubes. This power supply will suffice for servo amplifiers or applications where 2 to 5-percent supply changes are not detrimental. The specifications for the two supplies are listed in the table.

Modulators

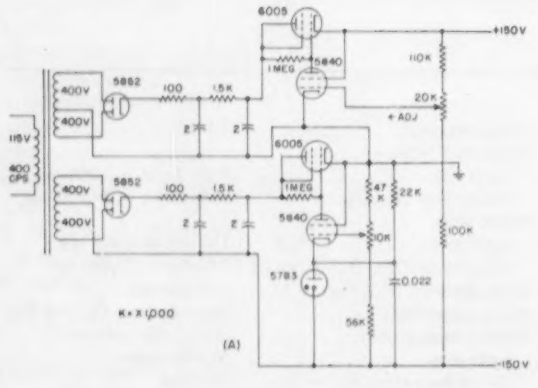
Modulators and demodulators are necessary in an automatic control system to convert from d-c to a-c or a-c to d-c.[8] In a modulator, the a-c output will be proportional to the d-c input and the phase will depend on the polarity of the input signal. For the demodulator the d-c output will be proportional to the a-c input and the polarity will depend on the phase of the input signal.

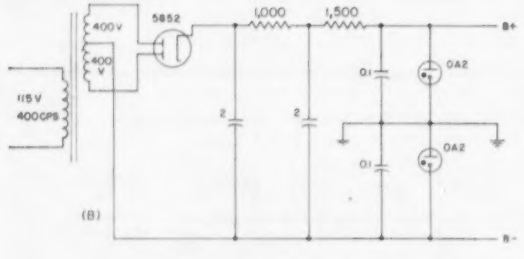
The decision as to which type of signal will be used arises from characteristics of the control sensor (pressure transducer, accelerometer, strain gage, phototube, etc) and the power actuation system. Where one is d-c and one is a-c, it is necessary to convert the signals.

Where it is desired to convert an a-c signal to phase sensitive d-c, a demodulator is used. Figure 6 is the schematic of a 400-cps demodulator with the specifications listed in the table.

Figure 7 is the schematic of a 400-cps modulator with specifications as given.

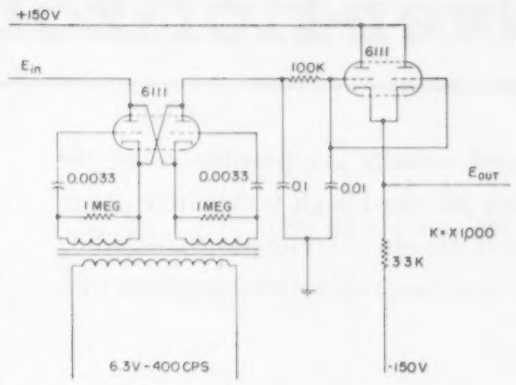
This modulator is designed to be utilized in the error portion of the control system. Therefore linearity and maximum output swing requirements are not excessive. An electromechanical chopper is recom-





	Series (A)	Volt. Reg (B)
Nominal output	±150 v	±150 v
Output current range	0–50 ma	35–60 ma
Load-change regulation (n-l to f-l)	0.7 percent	2 percent
Line-change regulation (105–125 v)	0.8 percent	3 percent
Output impedance	20 ohms	100–200 ohms
Ripple voltage	0.02 v rms	0.2 v rms
Max power requirements	115 v, 400 cps at 0.9 amp	115 v, 400 cps at 0.38 amp

FIG. 5—Series-regulated power supply (A) has excellent regulation; power supply using VR tubes (B) provides 2-to-5 percent regulation



Gain	1.3 to 1.4
Frequency response	2 db down at 20 cps
Phase shift	50 deg lag at 20 cps
Drift	0.062 v at output
Linearity (100,000-ohm load)	±2 percent
Input impedance	35,000 ohms
Output impedance	300 ohms
Load impedance	greater than 10,000 ohms
Max linear output swing	
100,000-ohm load	±100 v
10,000-ohm load	+100 v, −25 v
Output ripple with zero input	0.01 v, 400 cps
Max power requirements	6.3 v at 0.6 amp +150 v at 6 ma −150 v at 6 ma

FIG. 6—Demodulator is used to convert a-c signal to phase-sensitive d-c

mended where low drift rates, large voltage swings and high signal-to-noise ratios are required.[5] A subminiature plug-in modulator is shown in a photograph.

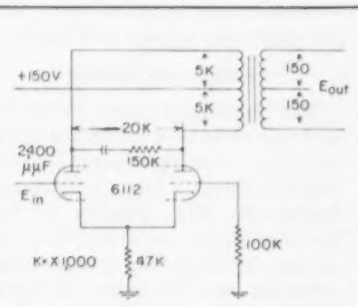
The modulator and demodulator may be utilized with different carrier frequencies with minor circuit changes. A subminiature plug-in phase-sensitive demodulator is shown in a photograph.

Pressure Control

Figure 8 illustrates an automatic system to control pressure accurately with reference to a pressure at a remote location. The reference pressure transducer transmits a low-level a-c voltage proportional to pressure. It is necessary to amplify this signal to drive a hydraulic control valve and actuator to displace a bellows that produces a pressure equal to the reference pressure.

A pressure transducer equal in characteristics to the reference transducer generates the feedback signal. Three of the building blocks are utilized. An a-c operational amplifier amplifies the error signal from the two transducers. A demodulator converts this error signal to d-c. A d-c operational amplifier provides error-network equalization to improve system stability and response and drives the electrohydraulic control valve of the hydraulic actuator.

The overall system could be put together and checked out in a matter of days utilizing the building-block techniques rather than in the weeks or even months that normally would be required if the electronic circuitry had to be developed to satisfy the requirements.



Gain	0.75 to 1.0
Frequency response	flat to 20 cps
Phase shift	30 deg to 20 cps
Drift	0.04 v at output
Linearity	±5 percent
Input impedance	10 meg or greater
Output impedance	4,000 ohms
Max output swing	0.8 v rms
Null level	0.01 v rms
Max power requirements	6.3 v at 0.3 amp +150 v at 0.2 ma

FIG. 7—Modulator for error portion of control system converts from d-c signal to a-c

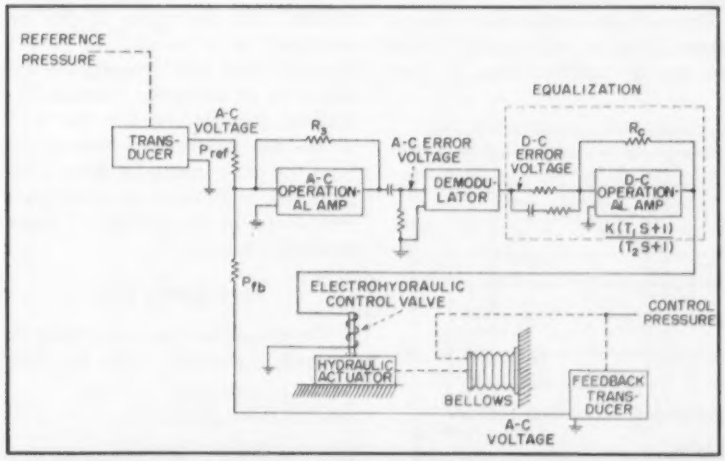


FIG. 8—Pressure regulating system uses three plug-in units: a-c amplifier, modulator and d-c amplifier

References

(1) G. A. and T. M. Korn, "Electronic Analog Computers", McGraw-Hill Book Company, Inc., New York, 1952.

(2) I. A. Greenwood, Jr., J. V. Holdam, Jr. and D. Macrae, Jr., "Electronic Instruments", p 375, McGraw-Hill Book Company, Inc., New York, 1948.

(3) B. Chance, V. Hughes, E. F. MacNichol, D. Sayre and F. C. Williams, "Waveforms", p 289, McGraw-Hill Book Company, Inc., New York, 1949.

Designing Over-Horizon

SUMMARY —— Long-distance, wide-band circuits are possible using the phenomenon of tropospheric propagation provided high transmitter power and diversity receiving equipment are used. Design considerations, including antenna gain and order of diversity, show how to set up a working system with a given percentage of reliability

POINT-TO-POINT communication with ultrahigh and super-high frequency transmissions has always appeared attractive because of three important considerations: high reliability as a result of freedom from ionospheric, atmospheric and geomagnetic disturbances; large information bandwidths; and privacy.

For many years these transmissions were believed to be of service only within or slightly beyond the radio horizon, although Marconi refused to recognize this limitation. However, with advances in transmission and reception techniques and in the technology of materials, it was demonstrated that useful signals could indeed be propagated well beyond the horizon, for distances of several hundred miles, possibly by a forward-scattering mechanism or by progressive partial reflections within the troposphere.

The discussion presented here outlines briefly the design of typical point-to-point over-the-horizon circuits, with emphasis on the operating margins that must be incorporated for accommodation of various types and grades of service.

Frequency Range

The frequency range from 100 to 5,000 mc is best suited for point-to-point over-the-horizon (o-h) transmissions. The propagation mechanism still operates at frequencies as low as 30 mc, but difficulties in achieving narrow-beam antennas and intrusion of ionospheric effects raise the lower limit to about 100 mc.

The upper frequency limit is established by the heavy absorption of very short microwave radiation by water vapor in the atmosphere. Accordingly, the relationships that will be employed in discussing various system parameters as a function of frequency will be treated as valid only in the range 100 to 5,000 mc.

The path loss between two points connected by an o-h link consists of two major contributions, a free-space loss and an over-the-horizon loss. This breakdown of the total loss is purely a bookkeeping convenience, since experimentally only the total loss can be measured. The free-space loss contains the frequency dependence, while the o-h loss (in the 100-5,000 mc range under discussion) is substantially independent of frequency.

Both losses, however, are dependent upon distance, with the o-h loss exacting the greater toll at long distances. The free-space loss represents the reduction in power density with increasing distance in free-space from the source of radiation. The frequency dependence of the free-space loss stems from the variation in collecting area (expressed in square wavelengths) of any receiving aperture of given gain as the frequency is altered.

The o-h loss is the loss remaining when the free-space loss expressed in decibels is subtracted from a median total loss (also in db) determined by a number of experiments[1,2,3] over the frequencies and distances of interest. Various theoretical foundations for the form of the o-h loss[4-7] have been given. It is the experimentally determined path loss that must be principally considered in the design of point-to-point o-h links.

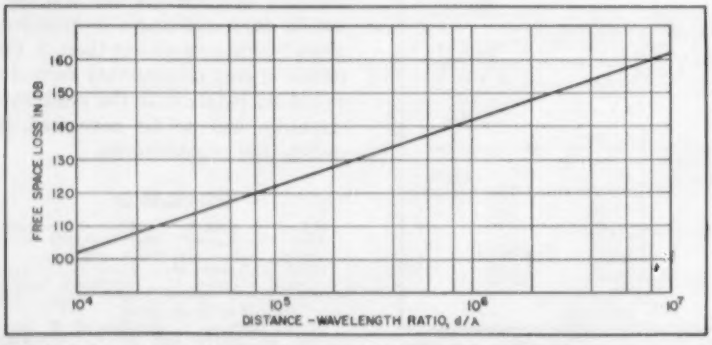


FIG. 1—Free-space loss is dependent upon distance and wavelength

Free-Space Loss

The free-space loss, L_{fs}, when expressed in decibels, takes the form

$$L_{fs} = 10 \log_{10} \frac{G_r G_t}{P_r/P_t} = \quad (1)$$

$$20 \log_{10} \left(\frac{4\pi d}{\lambda} \right) = 22 + 20 \log_{10} (d/\lambda)$$

Communications Links

By DAVID DAVIDSON and ALFRED J. POTÉ

Hycon Eastern, Inc.
Cambridge, Mass.

where P_r is the received power at a receiving antenna of gain G_r in the direction of the link, P_t is the transmitted power delivered to an antenna of gain G_t in the direction of the link, d is the distance between terminals and λ the wavelength. Note that it is the ratio d/λ, the distance in wavelengths, that determines the character of the free-space loss as shown in Fig. 1.

Over-Horizon Loss

Path loss L_p is the sum of L_{fs}, the free-space loss and L_{oh}, the o-h loss, all quantities being expressed in decibels. The empirical formulation of L_{oh} is

$$L_{oh} = A + B\,(d - d_o) \qquad (2)$$

where A is the o-h loss associated with the distance d_o and B is the rate at which the o-h loss accrues with distance (attenuation rate). For present purposes, d_o will be taken as 100 miles; the expression then becomes

$$L_{oh} = 57 + 0.13\,(d_{mi} - 100) \qquad (3)$$

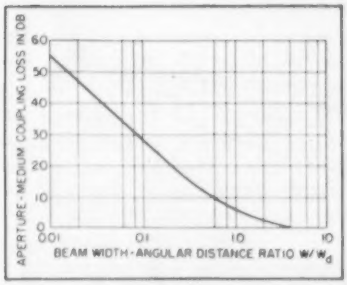


FIG. 3—Aperture-to-medium coupling loss results from failure to realize plane-wave antenna gain

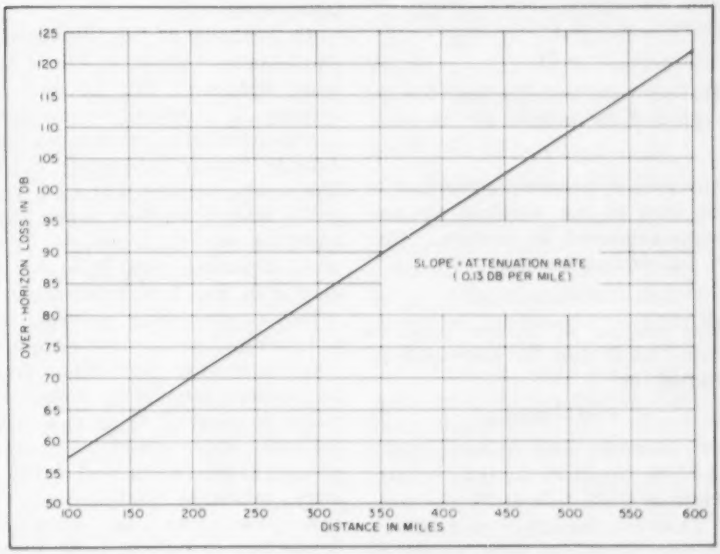


FIG. 2—Over-horizon loss for typical northern U.S. overland transmission

where d_{mi} indicates that distance should be entered in miles. The attenuation rate B is dependent on the average refractive properties of the atmosphere for the path under discussion. The value 0.13 db per mile is taken as typical for overland transmission in northern U. S. A. and southern Canada. It may be as low as 0.11 db per mile for semitropical, over-water paths and as high as 0.15 db per mile for dry, arctic conditions.

Parameter L_{oh} is plotted in Fig. 2 for the case of $B = 0.13$ db per mile. For other values of B, some adjustment might be necessary for the value of A.

Total path loss L_p in decibels, can then be written as

$$L_p = L_{fs} + L_{oh} + 79 + 20\log_{10}(d/\lambda) + 0.13\,(d_{mi} - 100) \qquad (4)$$

Antennas

The ratio of antenna gains to the ratio of received and transmitted powers, as shown in Eq. 1, implies that transmitted power may, up to a point, be exchanged for antenna power gain. Since increasing the antenna gain results in a narrowing of the antenna beam, an exchange of transmitted power for antenna gain is accompanied by increased privacy. This is not directly evident from Eq. 1.

Assuming that paraboloidal reflector antennas of diameter D are used, with illumination efficiencies of 64 percent, numerical power

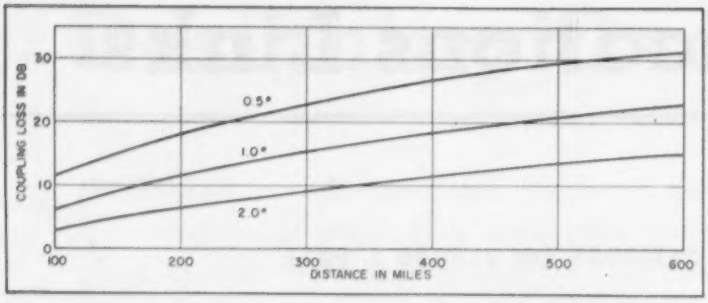


FIG. 4—Coupling loss for three different beam widths

gain is given by

$$G = 2\pi\,(D/\lambda)^2 \qquad (5)$$

The half-power beam width in degrees, w°, is given[1] by

$$w^\circ = 70\lambda/D \qquad (6)$$

The net path loss L_{net} can then be expressed in decibels as

$$L_{net} = L_{fs} - G_s + L_{ca} \qquad (7)$$

where G_s is the system gain and is the sum of the terminal antenna gains expressed in decibels. That is, for similar antennas

$$G_s = 20\log_{10}2\pi\,(D/\lambda)^2 \qquad (8)$$

The relation of system gain to beam width can be expressed in decibels as

$$G_s = 89 - 40\log_{10}w^\circ \qquad (9)$$

For example, with a beam width of 1°, G_s equals 89 db; with a beam width of 2°, G_s falls to 77 db.

Thus far, the effect of increased antenna gain has been related to increased privacy and a reduction in the net path loss. When the antenna beams become extremely narrow (large apertures), the volume of the atmosphere intercepted by the beams does not contribute as much to the scattering process[6] as it would with wider beams. The result can be regarded as an increase in o-h loss or as a failure to realize the full plane-wave antenna gain; the latter view is presently more prevalent.

This aperture-to-medium coupling loss L_c has been defined theoretically[8] under the assumption of identical terminal antennas. The magnitude of L_c depends on antenna beam width and distance between stations. As shown in Fig. 3, L_c is a function of w/w_d, where w is the beam width and w_d the angular distance between stations for an assumed radius of the earth of 5,000 miles. Loss L_c is a function of distance only for a given antenna beam width.

An example of this dependence on distance is given in Fig. 4 for beam widths of 0.5, 1.0 and 2.0 degrees. It is difficult to determine L_c experimentally, but this has been done[9] by Lincoln Laboratory, M.I.T. The results indicate that L_c is generally several decibels lower than predicted in Fig. 3 and 4. Temporal variations noted in L_c are indicated in Fig. 8 of Reference 9.

Besides increasing privacy, the narrowing of an antenna beam provides increased protection from the strong, interfering reflections caused by aircraft flying in or near the path. These reflections produce violent, rapid fading and furthermore, introduce multipath distortion that may be extremely deleterious to certain pulse transmissions and which may also restrict the effective information bandwidth.

A radio receiver amplifies and demodulates not only the input signal but also the noise voltages generated in the antenna and in its own resistances and tubes. Since all antennas generate noise, all received signals are inherently contaminated by noise. To this minimum noise the receiver adds its own noise. As a practical matter, only the first two stages of a receiver contribute significantly to the noise output.

A measure of this additional noise output is the so-called noise factor that may be defined as the quotient of the s-n ratio at the receiver input terminals and the s-n ratio at the receiver output. When expressed in decibels it is called the noise figure F_n. The minimum attainable noise figure in a receiver depends largely on the state of the art. In general, the figure increases with frequency.

For receivers of current design, at frequencies above 100 mc, a conservative estimate of the noise figure in decibels is

$$F_n = 5.3 + 3.6\log_{10}(f_{mc}/100) \qquad (10)$$
$$= 3.6\log_{10}f_{mc} - 1.9 \qquad (f_{mc} \geq 100)$$

where f_{mc} is the frequency in mc.

For a frequency of 2,000 mc Eq. 10 yields $F_n = 10$ db, a figure that agrees well with recent developments[10] in r-f amplifier design.

Noise appearing in a receiver when an antenna is connected may be considered as arising in a resistance equal to the radiation resistance of the antenna, assuming the antenna is not trained on a cosmic noise source. This thermal noise power as it affects the receiver output is

$$P_n = k\,T\,B \qquad (11A)$$

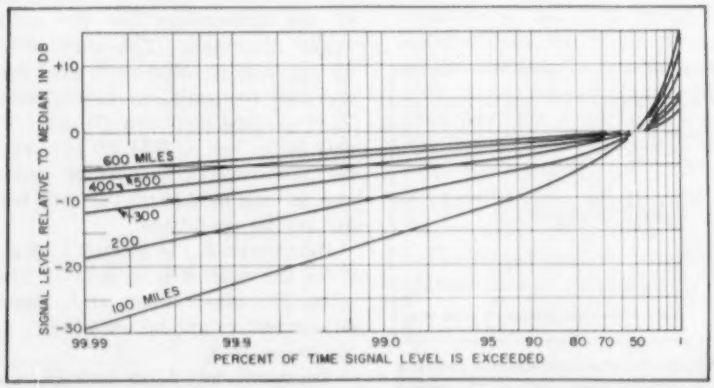


FIG. 5—Long-term fading characteristic based on 100-mc data

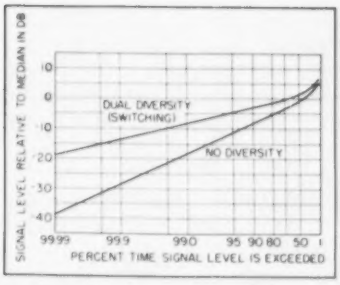


FIG. 6—Short-term fading characteristic taking place within an hour

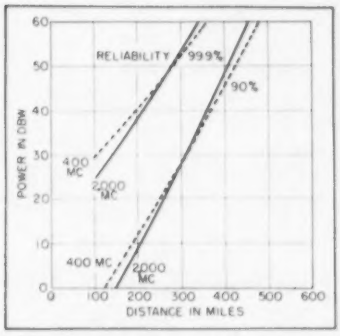


FIG. 7—Required power depends upon reliability desired

where P_n is the noise power in watts, k is Boltzmann's constant, T is the absolute temperature and B is the receiver i-f bandwith in cps.

The minimum noise output of a receiver is proportional to the i-f bandwidth. Hence, for low noise output, the receiver must be designed for the minimum bandwidth commensurate with the rate of information involved.

As an example, assume that a proposed link is to handle a single teleprinter channel at 60 words per minute.

While in an ideal wire circuit a 60 wpm transmission would require a bandwidth of only 22.5 cps, the characteristics of practical wire transmission circuits are such that 100 cps is necessary. In a radio link more bandwidth may be used to give the required reliability in the presence of fading. For conventional frequency-shift (fsk) systems a bandwidth of about 1,000 cps is needed for a 60-wpm circuit. This value of 1,000 cps will be used as reference bandwidth B_o.

In Eq. 11A the noise introduced by the antenna in the range of frequencies discussed is described by a temperature T which is customarily taken as 60 F (289 degrees absolute). Since then $kT = 4 \times 10^{-21}$ watt-seconds, Eq. 11A becomes, if all figures are expressed in decibels

$$P_n\,(60F) = 10 \log_{10} B - 204 \quad (11B)$$

For the reference bandwidth B_o Eq. 11B becomes (relative to 1 watt)

$$P_n\,(60F) = -174 \text{ dbw} \quad (11C)$$

For any other bandwidth simply add 10 $\log_{10}$ (B/B_o) to the right hand side of Eq. 11C. Some typical services with corresponding bandwidth figures are listed in Table I.

Signal-to-Noise Ratio

In a communications link, the transmitter not only must deliver enough signal power to overcome noise in the receivers; it must also provide enough additional signal power for acceptable readability. Readability depends upon the signal-to-noise ratio at the detector input and upon the possible improvements achieved by the method of detection for some systems[12] of modulation.

With frequency modulation, for example, the improvement is proportional to the square of the modulation index. For a given information rate the latter can be increased only at the expense of greater bandwidth, which in turn involves more thermal noise and hence raises the level to which a signal must rise before the improvement can be realized.

In the examples in this discussion it is assumed that an input signal-to-noise ratio of 10 db is just acceptable for reception of 60-wpm teleprinter. With other systems an adjustment of this figure will be necessary; for example, in commercial (a-m) television a signal-to-noise ratio of at least 40 db is required for high-grade service.

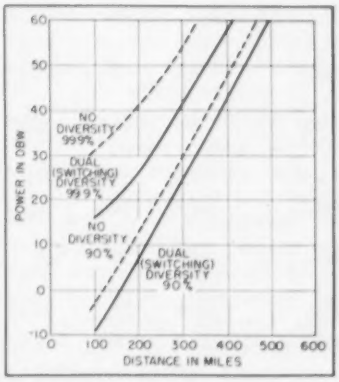


FIG. 8—Advantage of dual diversity for teleprinter channel

Table I—Teleprinter and Voice Requirements

Teleprinter, 60 wpm, fsk 425 cps	i-f bandwidth [11]	db added to −174 dbw (Eq 11C)
1 channel	1,000 cps	0
4 channels	1,700	2.3
12 channels	3,400	5.3

Voice, 4 kc per channel	Subcarrier modulating frequency	i-f bandwidth [13] (mod index = 1.5)	db added to −174 dbw (Eq 11C)
12 channels	12- 60 kc	468 kc	26.7
24 channels	12-108 kc	842 kc	29.3
36 channels	12-156 kc	1,220 kc	30.9

Fading Safety Margins

The o-h loss L_{oh} shown in Fig. 2 represents a median value obtained from experimental data. There is a long-term, seasonal fading that is not yet completely known for the entire frequency range 100-5,000 mc. However, some very complete data[1] have been obtained through transmissions in the commercial f-m band centered at 100 mc. It is this long-term fading characteristic that is displayed in Fig. 5.

Other experimental evidence indicates that the 100-mc information may be applied to much of the uhf range. As Fig. 5 shows, the long-term fading becomes less and less pronounced as the length of the link is increased. For 99-percent reliability on a long-term basis it is necessary to supply a margin of about 11 db to the median o-h loss for a path 200 miles long, while at 400 miles only 5.0 db need be supplied.

Short term, within-the-hour, fading follows a Rayleigh law; this is shown in Fig. 6 for a nondiversity system, and for a dual-diversity system that merely utilizes the better of two signals received in widely separated antennas. This technique is known as switching diversity and is less effective than combining diversity.[14]

In computing the total safety margin for fading, it is well to

note that long-term and short-term fading are essentially independent. Long-term fading establishes the immediate median level upon which within-the-hour fading is superimposed. It is thus reasonable to strive for a system that will possess a given signal-to-noise ratio for at least a certain percentage of time on a long-term basis and in addition will provide perhaps equal protection on a short-term basis.

Whatever combinations of fading margins are used, there will be periods of the year characterized by low path loss during which most of the fading margin incorporated results in the realization of an unusually high within-the-hour reliability. Weighting of the two types of fading margins will be influenced by the kind of information to be transmitted and whether errors will accumulate often enough to be objectionable.

A complete consideration involves not only the fading statistics shown in Fig. 5 and 6 but also the effect of the rate of fading upon the transmitted information. The fading rate increases with frequency.[1]

In an illustrative example reliability will be assumed for q percent of the time on a long-term basis along with reliability p percent of the time on a short-term basis. The two fading margins are simply added.

Terminal Loss and Site Noise

Certain other losses are always considered when designing o-h links. These are losses in transmission lines and connectors at each terminal and losses in effective operating margins owing to site noise.

Transmission line and connector losses arise from the attenuation characteristics of the lines connecting transmitter to antenna, antenna to receiver, from the power wasted in impedance mismatches at each terminal and from power lost to connector junctions. These losses generally increase with frequency. The losses at transmitter and receiver may be conveniently grouped together and denoted by L_j. A typical behavior of this loss in decibels is

$$L_j = 5 \log_{10} (f_{mc}/100) = 5 \log_{10} f_{mc} - 10 \quad (12)$$

The losses L_j should be evaluated

Table II—System Parameters At 400 Mc

Item	100 mi	200 mi	300 mi	400 mi	500 mi	600 mi	Remarks
$L_{fs}+L_{oh}$	185	20	221	239	257	275	Eq 2 and 3
L_j	3.0	3.0	3.0	3.0	3.0	3.0	Eq 10
G_s	−52	−52	−52	−52	−52	−52	20-ft dish
L_e	0	0.9	1.8	2.7	3.6	4.5	from Fig. 3
s/n	10	10	10	10	10	10	acceptable teleprinter
F_n	7.5	7.5	7.5	7.5	7.5	7.5	Eq 8
$10 \log_{10} B$	30	30	30	30	30	30	$B = 1{,}000$ cps
$10 \log_{10} kT$	−204	−204	−204	−204	−204	−204	$T = 60$ F dbw
P_m	−20.5	−1.6	17.4	36.2	55.1	75.0	median
ML_{90}	9.0	5.5	3.5	2.5	2.0	1.8	based on 100-mc data (Fig. 5)
MS_{90}	8.0	8.0	8.0	8.0	8.0	8.0	no diversity Fig. 6
P_{90}	−3.5	11.9	28.9	46.7	65.1	83.8	plotted in Fig. 7
$ML_{99.9}$	22.5	14	8.5	7.0	5.0	4.0	based on 100-mc data (Fig. 5)
$MS_{99.9}$	28	28	28	28	28	28	no diversity Fig. 6
$P_{99.9}$	30.0	40.4	53.9	71.2	88.1	106	plotted in Fig. 7
$P^{(2)}_{90}$	−8.8	6.6	23.6	41.4	59.8	78.5	dual diversity switching Fig. 6
$P^{(2)}_{99.9}$	15.2	25.6	39.1	56.4	73.3	91.2	dual diversity switching Fig. 6

Table III—System Parameters At 2,000 Mc

Item	100 mi	200 mi	300 mi	400 mi	500 mi	600 mi	Remarks
$L_{fs}+L_{oh}$	199	216	235	253	271	289	Eq 2 and 3
L_j	6.5	6.5	6.5	6.5	6.5	6.5	Eq 10
G_s	−80	−80	−80	−80	−80	−80	20-ft dish
L_e	3	7	10	13	15	16	from Fig. 3
s/n	10	10	10	10	10	10	acceptable teleprinter
F_n	10	10	10	10	10	10	Eq 10
$10 \log_{10} B$	30	30	30	30	30	30	$B = 1{,}000$ cps
$10 \log_{10} kT$	−204	−204	−204	−204	−204	−204	$T = 60$ F; dbw
P_m	−25.5	−4.5	17.5	38.5	58.5	77.5	median
ML_{90}	9.0	5.5	3.5	2.5	2.0	1.8	based on 100-mc data Fig. 5
MS_{90}	8.0	8.0	8.0	8.0	8.0	8.0	no diversity Fig. 6
P_{90}	−8.5	9.0	29.0	49.0	68.5	87.3	plotted in Fig. 7
$ML_{99.9}$	22.5	14.0	8.5	7.0	5.0	4.0	based on 100-mc data Fig. 5
$MS_{99.9}$	28	28	28	28	28	28	no diversity Fig. 6
$P_{99.9}$	25.0	37.5	54.0	73.5	91.5	99.5	plotted in Fig. 7
$P^{(2)}_{90}$	−13.8	3.7	23.7	43.7	63.2	82.0	dual switching diversity Fig. 6
$P^{(2)}_{99.99}$	10.2	22.7	39.2	58.7	76.7	94.7	dual switching diversity Fig. 6

carefully for a given equipment, transmission line and operating condition. In practice, these losses may be found to be greater than that indicated by Eq. 12 and frequently losses that are charged mistakenly against the propagation path will be found to occur at the terminals.

At any appreciable distance from a terminal the cross section of even a narrow antenna beam is large, so that the system may become vulnerable to impulse noise generated near the path by a city, a town, a manufacturing activity or a radar transmitter. In that event, an additional amount of power may be required for the link to overcome this site noise. No simple rule exists for the margin to be allowed for this kind of noise, since this will depend on the character of the noise and the way in which the improvement normally afforded by the modulating method[13, 15] is degraded in its presence.

Illustrative Example

An organization wishes to provide over-the-horizon communication for a number of links of various lengths and has two frequency allocations at its disposal, 400 mc and 2,000 mc. Equipment can be obtained for these frequencies. The paraboloidal antenna aperture must not exceed 20 feet in diameter because of cost and mounting difficulties. It is desired to determine the power required for both 90 and 99.9-percent reliability, for 60-wpm teletype, single channel, fsk, with a frequency shift of 425 cps.

The power required, in decibels above 1 watt, for median service, 50-percent the time, is given by

$$P_m = L_{fs} + L_{ca} - G_s + L_c + L_j + F_n + (s/n) + 10 \log_{10} B_n - 204 \quad (13)$$

The symbols have the same meanings as before and s/n is the signal-to-noise ratio expressed in decibels. For service at least q percent of the time on a short-term and a long-term basis

$$P_q = P_m + ML_q + MS_q \quad (14)$$

where P_q is the power required for q percent reliability, ML_q is the long-term fading margin for q percent reliability and is a function of distance, MS_q is the short-term fading margin for q percent reliability.

Tabulations of the various losses and system parameters are given for 400 mc in Table II and for 2,000 mc in Table III. The results are plotted in Fig. 7 for the 90 and 99.9-percent reliabilities desired. While the tables show powers in excess of 60 dbw (1 megawatt) for completeness, the curves in Fig. 7 are carried only up to this level.

Interpretation

Added gain provided by the 20-foot paraboloid at the higher frequency is hardly sufficient at the longer distances to overcome the additional free-space loss. This is the result of the increasing effect of L_c, the aperture-to-medium coupling loss for the narrowed beam.

Curves in Fig. 7 are plotted for distances from 100 to 600 miles. Some reservations should be attached to extension of the curves for distances of less than 100 miles. In that range, depending upon the height of the terminal antennas, there may be an appreciable diffracted surface wave present that would serve to widen the fading range and in any case, would provide substantially different short-term fading characteristics[1] than are indicated by Fig. 6.

The curves do not include any gains or losses incurred by the presence of obstacles in the path. It is assumed that along the path to the horizon the clearance between the path and any obstacle exceeds the radius of a first Fresnel zone. If obstacles are present, the computation must be altered as recommended[1, 16] in the literature.

The advantage to be gained by employing dual diversity of the switching type at one terminal is illustrated in Fig. 8 for 400-mc transmission. While diversity can be regarded as a means of saving transmitted power, if it is done by spacing the receiving antennas, or as an increase in reliability, it is instructive to evaluate its advantage in extending the working distance possible with a given transmitted power.

Table IV presents the additional distances obtainable by including the diversity fading margins as scaled from Fig. 8. With higher orders of diversity and with systems that combine[17] the outputs of spaced antennas, greater gains in distance or savings in power are possible.

Table IV—Additional Distance With Diversity at 400 Mc

Reliability	Order of Diversity	1 kw	10 kw	100 kw	1,000 kw
90%	1	308 mi	366 mi	420 mi	472 mi
90%	2	336	384	448	500
	Additional Distance:	28	28	28	28
99.9%	1	98	200	275	340
99.9%	2	217	300	360	420
	Additional Distance:	119	100	85	80

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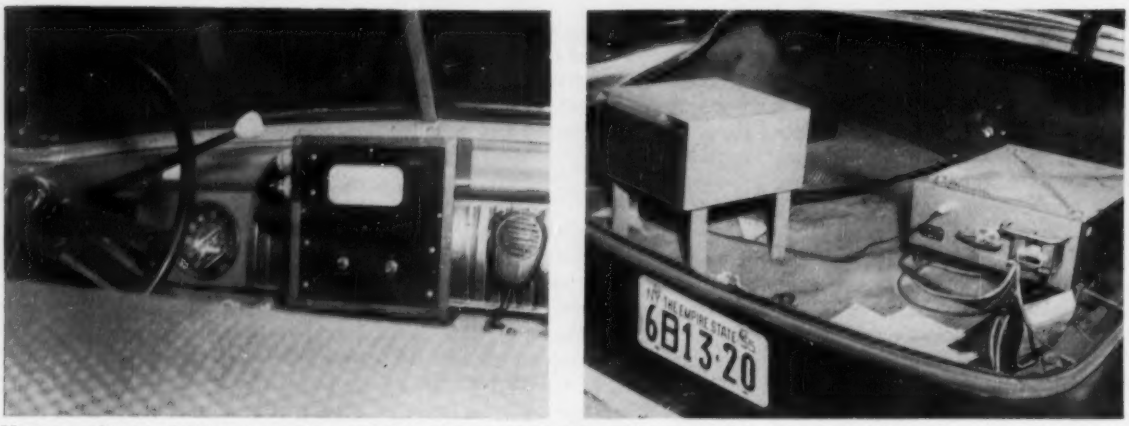

Meter on police-car dashboard records speed of passing car. Radar transmitter and receiver are mounted in trunk

How Accurate Are

SUMMARY —— Erroneous readings of radar units used by police departments to enforce speed laws arise from carrier frequency shift of transmitter, parallax when radar car is parked off highway, and multiple reflections from other passing cars or nearby objects. However, these errors usually give the speeder a break

MOST SPEED radars commercially available have the basic form shown in Fig. 1 and depend upon precise measurement of the Doppler shift in signal frequency. Energy radiated by the transmitter at a frequency f_o is reflected by the moving target and gives rise to a detected signal having a frequency $f_o + f_d$.

The relative speed V of the automobile is related to the Doppler frequency f_d and to f_o by

$$V = Cf_d / 2f_o$$

where C is velocity of propagation of the radar waves. Therefore, if f_o is known, f_d provides a direct and precise measure of V.

In the system shown the received signal is mixed with feedthrough power from the transmitter and the difference frequency f_d is filtered out and amplified. The signal is then limited and a frequency counter and meter or pen recorder provide a direct speed reading. Photographs show a typical radar installation in a police car.

The principal sources of error in the radar used resulted from shifts in carrier frequency, counter and/or meter inaccuracies and errors in reading due either to parallax or human error. Other errors resulted from the fact that the quantity measured is the relative speed and not the linear speed of the vehicle

Table I—Speed-Counter Errors

Input Frequency in cps	Calculated Speed in mph	Indicated Speed in mph	Radar Error in mph	Percent Error
60	8.2	7.0	—1.2	14.6
120	16.4	15.0	—1.4	8.5
180	24.6	23.5	—1.1	4.5
240	32.9	33.0	+0.1	0.3
300	41.1	41.0	—0.1	0.2
360	49.3	49.0	—0.3	0.6
420	57.6	57.5	—0.1	0.2
480	65.8	65.5	—0.3	0.5
540	73.9	73.5	—0.4	0.5

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ENGINEERS AS EXPERT WITNESSES

Nationwide, law-enforcement agencies are readying a crackdown on careless driving. The coming year may see vastly expanded use of radar for speed control.

However, in several instances the validity of radar speed readings have been challenged in court. Such cases may become more numerous.

The arresting agency must then call upon a qualified expert to testify to the accuracy of the radar. Thus, it behooves the electronics engineer, who may be called upon, to know something of the accuracies attainable with a typical unit.

The author describes results of independent accuracy tests made by him for the City of Buffalo traffic department. The results were observed on a single unit and cannot be applied in general. However, they indicate the precision that can be achieved and point out certain situations in which operation is unreliable

Radar Speed Meters?

relative to the ground. Reference to Fig. 2A shows that the speed of the car relative to point P is equal to $V_c \cos \theta$. The error in the radar observation comes from the cosine factor and is negligible for small values of θ. It always yields a reading which underestimates the actual speed of the target vehicle.

The first method used to measure radar performance involved measurements of f_d followed by meter calibrations taken with known frequency inputs to the counter. The second method employed a precision odometer attached to a test vehicle. Radar readings were compared with readings obtained on the odometer and related to time. The first set yields information about the inherent accuracy of the radar and the odometer readings shed light on the overall performance under actual operating conditions.

Precision Measurements

Precise error measurements were made by injecting signals of known frequency into the speed counter. Integral multiples of power-line frequency were used. The corresponding speed represented by each of these frequencies was computed from the Doppler equation using the measured carrier frequency of 2,447 mc. Line frequencies were accurate to within 0.08 cycle. The results are shown in Table I.

In actual operation, the carrier frequency will drift varying amounts depending upon external factors such as temperature and line voltage. It was not possible to make long-term frequency checks on the unit tested but it was assumed frequent adjustments would keep f_o within ± 10 mc. Based upon this assumption the maximum variation in speed readings will be approximately ± 1.4 mph at 35 mph.

It was noted during these tests that the readings were sensitive to voltage variations in the radar-car power supply. Subsequent tests showed that the errors in Table I which were taken with car generator off, were increased by from 5 to 6 percent with the engine idling.

Numerous tests were made in the

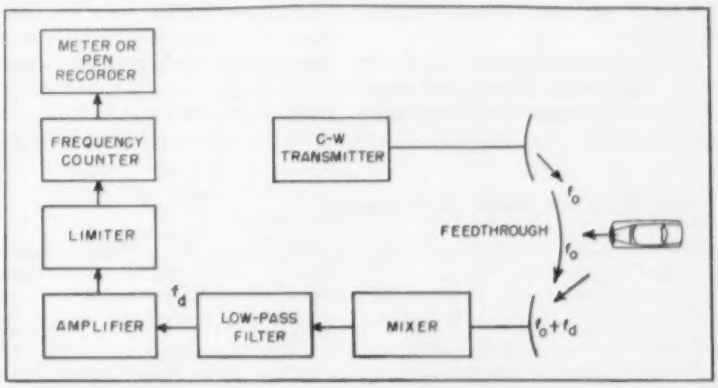


FIG. 1—Speed radar depends for its operation on Doppler frequency shift

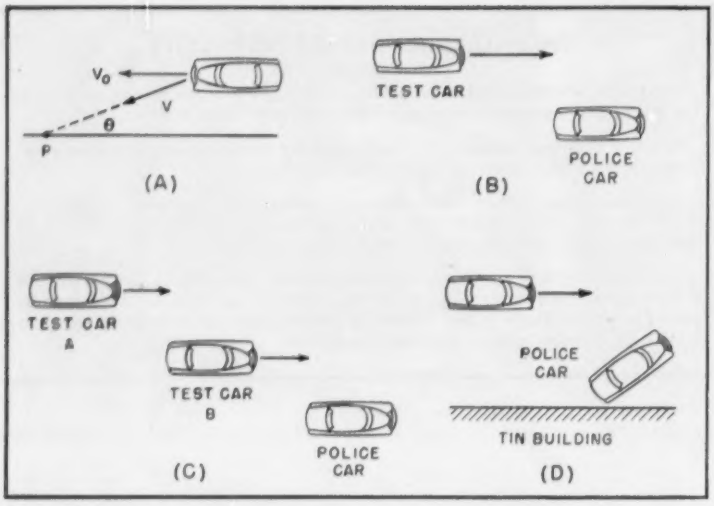


FIG. 2—The parallax problem (A), typical installation (B), condition where echoes from two passing cars may cause inaccuracy (C) and test setup for studying effect of reflection from nearby object (D)

manner illustrated in Fig. 2B. Radar readings made by police officers were compared with those made by an observer riding in the test vehicle and reading the odometer. The test car was driven close to the radar car to minimize cosine errors. Table II shows the results of these runs.

The total errors include contributions from the radar itself, external factors such as reflections and reading errors, the cosine term and the odometer. Because of the high degree of inherent radar accuracy it may be assumed that it is more accurate than the odometer. However, comparison of the radar readings with those of the odometer makes it possible to estimate the influence of factors not associated with the internal operations of the radar, such as the effect of the cosine factor and secondary radar reflections.

While the spreads were relatively large the average errors were small in all speed ranges. Readings which overestimated the target's speed were rare and on the average the errors favored the driver.

To confirm expected cosine errors, some runs were made which were similar to those of Fig. 2B, but with a wider passing margin. Passes were made at distances from 6 to 15 feet with increasing errors. Readings generally took place at ranges between 50 and 65 feet from the radar. When cosine errors were estimated for the individual cases and compensated for, the residual errors were comparable to those of Table II.

To assess the radar's performance in situations where two cars pass it simultaneously several runs of the type shown in Fig. 2C were made. Several speed differentials between *A* and *B* were tried and runs were made at various values of individual speeds. The readings varied over such a wide range that they were considered unusable for determining the speed of either *A* or *B*. In one case *A*'s speed was 35.5 mph, *B*'s was 21 mph and the radar gave a single reading of 24 mph.

Tests were also run in the manner illustrated in Fig. 2D. These were intended to determine the effects of nearby reflecting objects. The readings obtained gave speeds which were consistently lower than would normally be the case. The indications were similar to those observed with two cars because the radar sees not only the car itself but its image in the reflector as well.

Maximum parallax errors were measured by setting the meter precisely at given speeds and then reading values observed from either side. The results are tabulated in Table III. By observing the manner in which police officers made this reading, it was estimated that errors due to this effect were practically always less than 0.2 mph.

Conclusion

Speed errors made by the radar were almost always in a direction which favored the passing vehicle. The one exception occurred when observations were made with the engine in the radar car idling. The radar then consistently overestimated actual speeds.

Principal errors arose from differences between actual and relative speeds, speed-counter inaccuracies especially those due to shifts in line voltage, meter inaccuracies and parallax. Additional errors can be expected as a result of carrier-frequency shifts. While these were not measured over a long period it is assumed that they are periodically checked and kept within ±10 mc. Periodic calibration of the counter and speed meter are necessary but the reported measurements were made without prior calibration.

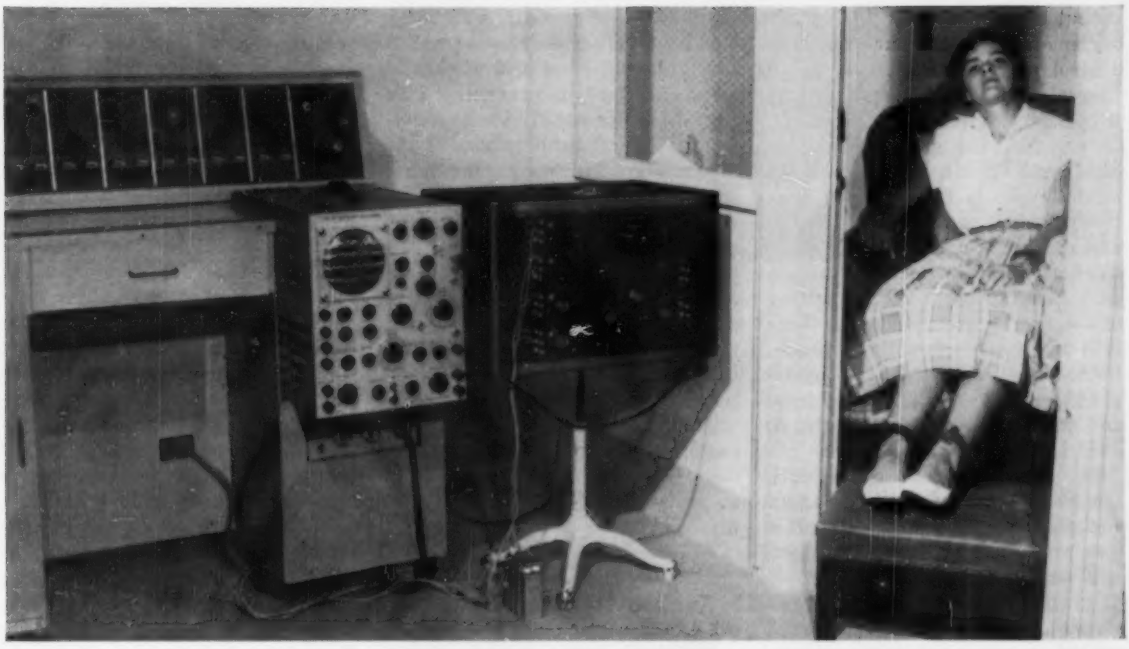
The author acknowledges the assistance of Walter A. Flood and John J. Earshen in conducting these tests.

Table II—Speed Meter vs Odometer

Speed Ranges (mph)	20-30	30-40	40-50
Spread in errors (mph)	6.3	4.0	1.5
Maximum error (mph)	−5.3	−3.0	−2.0
Minimum error (mph)	+1.0	+1.0	+0.5
Average total error (mph)	−1.7	−0.9	−1.1
Average radar error (mph) (See Table I)	−0.9	−0.03	−0.2

Table III—Parallax Errors

Speed	Maximum Error
60	±2.0
40	±1.5
30	±1.0
20	±1.0



Electronic switch at center measures heart-muscle potentials of patient at right. High-gain preamplifiers of electroencephalograph at left bring signal levels up to that required by switch. Switch effectively converts oscilloscope into four-beam instrument

Multichannel Switch For Biological Observations

SUMMARY —— Simultaneous observation of four signals is provided by oscilloscope accessory. Each channel is a d-c amplifier with a gain of five. Frequency of switching between channels is variable between 1 and 30,000 cps. Unlimited number of channels can be added if necessary

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Loma Linda, California

DESIGNED as an oscilloscope accessory, the electron switch to be described permits simultaneous observation of related biological phenomena such as electrical potentials occurring across membranes in the body of an animal or man.

The instrument as constructed provides a maximum of four channels; the principle of operation, however, makes it possible to have any number of channels desired by the addition of five triodes for each additional channel. A channel switch sets the number of channels in use and a channel-stop switch confines the operation to continuous observation of any single channel desired. Switching transients are of extremely short duration, essentially limited by stray capacitance. Frequency of switching is continuously variable from 1 to 30,000 cps, the repetition rate being 1 to 30,000 divided by the number of channels in use.

In addition to the signal output, a pulse output with either positive or negative polarity is available. If the internal multivibrator is made inoperative, the same terminals may be used as an external-pulse input to actuate the switching circuits. This external pulse may be regularly produced at low frequencies or irregularly, as desired.

In the diagram of Fig. 1, the

output of multivibrator V_1 is made asymmetrical so the fine frequency control may be affected by R_1 in the left-hand grid circuit, which lengthens the time constant of discharge for that grid. The right-hand grid circuit, from which the output pulse is taken, has a relatively short time constant of charge and discharge and since the transient time of switchover in this grid is independent of the setting of the fine frequency control, there is a more consistent pulse shape. Switch S_1 inactivates the multivibrator. This permits pulsing from an external source through C_1 and S_{2a}.

In the pulse-forming circuit, triode V_{2A} is biased positively so an additional positive pulse is ineffective, but it is responsive to a negative pulse. From the plate of V_{2A} the resultant positive pulse is fed through differentiator C_2R_2 to the grid of V_{2B} which is biased to cutoff. The negative pulse output of V_{2B} is available for control of the switching circuit.

Dual-triodes V_3, V_4, V_5 and V_6 are flip-flop or trigger-circuit stages. The negative pulse formed in V_2 is fed to the left-hand grid of each of these flip-flops in parallel. This negative pulse would be without effect if the left-hand triodes of the flip-flops are nonconducting; but if one of them, say flip-flop V_3, is conducting the negative impulse would cut it off and the corresponding right-hand triode would begin conduction producing a negative pulse on its plate. This pulse, fed to the right-hand grid of flip-flop V_4, would cut off its right-hand triode, cause its left-hand triode to conduct and thus prepare it for reception of the next pulse from V_2. Successive pulses from V_2 would step the left-hand conduction from flip-flop V_3 to V_4 to V_5 to V_6.

Ring Operation

If the last in line is connected back to the first making a ring, a cyclic rotation of this left-hand conduction is obtained which can be used to switch the channels. The number of flip-flops in this ring determines the number of channels in use. Switch S_3 makes it possible to feed flip-flop V_3 from the output of V_4 or V_6, etc., thus controlling the number of flip-flops in the ring and the number of channels in use.

When the number of channels is three or more, it is necessary to establish the condition that only one flip-flop shall have left-hand conduction. When the instrument is first turned on, for example, more than one flip-flop may show left-hand conduction and a form of multiple wave will travel around the ring. The single condition may be established, however, by returning one of the right-hand grids, for a time as long as one cycle of operation, directly to the common cathode return at −255 volts.

The various conducting cycles travel around the ring and stop at the flip-flop with the shorted grid, leaving that flip-flop the only one with left-hand conduction. Switch S_4 performs this function, but since shorting the grid stops the switching S_4 has been designed to stop the switching on any desired channel at the will of the operator and

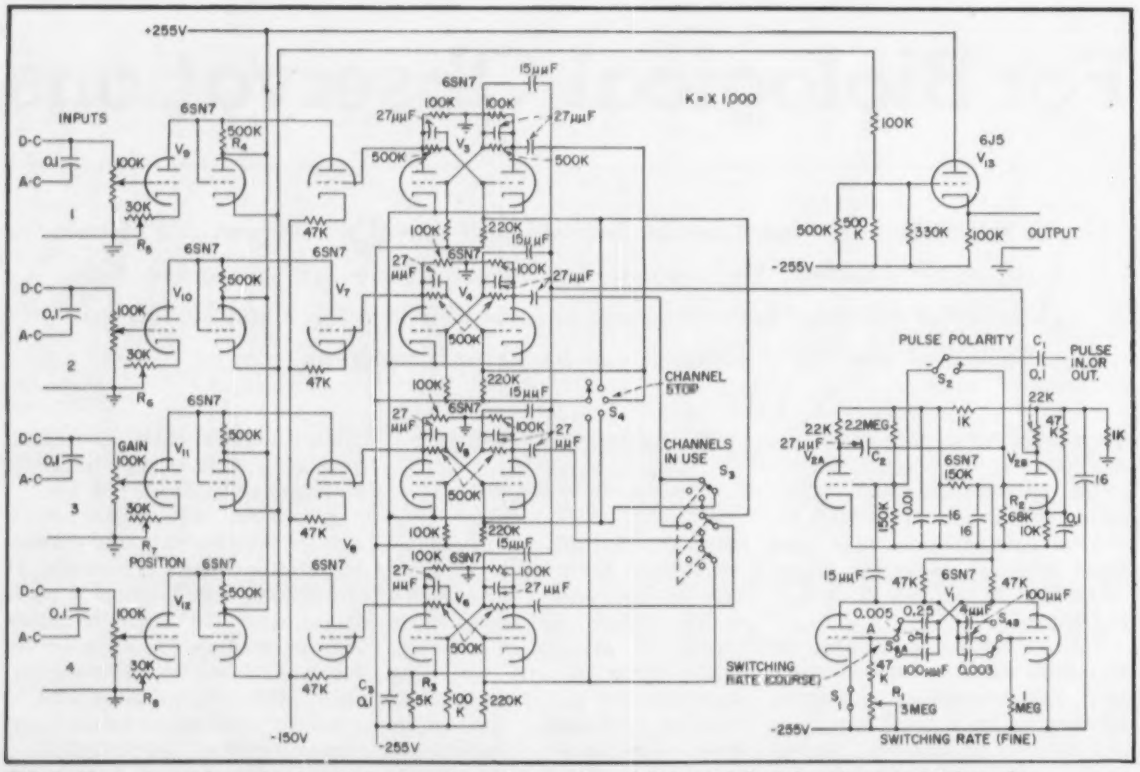

FIG. 1—Electronic switch requires five triode stages for each input channel. Voltages indicated are from regulated supplies

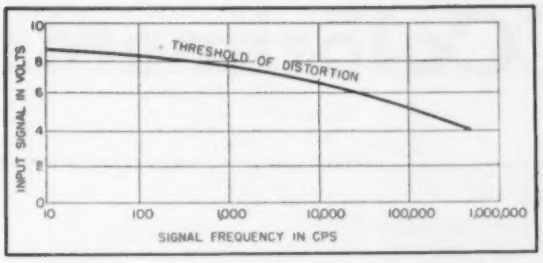

FIG. 2—Threshold of distortion vs input signal and frequency

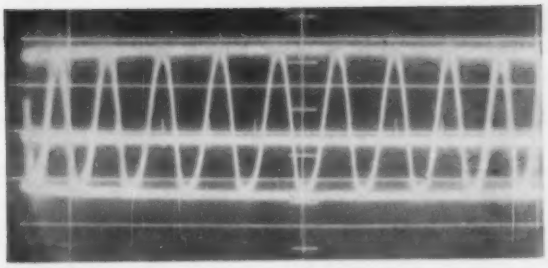

FIG. 3—Using spare channels as markers

serves as a channel stop switch as well as to establish the one-channel-at-a-time condition.

The C_3-R_3 bias combination for the flip-flops maintains a constant bias voltage since the number of conducting triodes is invariable. Capacitor C_3 is necessary to smooth switching transients.

Sections of V_7 and V_8 are direct coupled to the plates of corresponding left-hand triodes of the flip-flops. If the flip-flop is not conducting the plate voltage is high and the corresponding V_7 or V_8 triode is conducting, but if the flip-flop is conducting, the V_7 or V_8 triode is cut off and is not conducting. All of the V_7 or V_8 triodes except one are conducting at any one instant.

Signal Inputs

Dual-triodes V_9, V_{10}, V_{11} and V_{12} are the input stages. The first triode sections are essentially triode amplifiers with gain controls in the grid circuits and variable bias or positioning controls in the cathode circuits. These amplifiers are direct coupled to the second triode sections, which operate as cathode followers. Gating is accomplished, in the first channel for example, by drawing the plate current of the first triode section of V_9 and the associated triode of V_7 through the same plate-load resistor, R_4. If the V_7 triode is conducting, the drop through R_4 reduces the grid voltage of the cathode follower to a point beyond cutoff and the plate voltage of the first triode of V_9 to a point near ground potential. Thus only one channel at a time is operative.

The output of the several cathode followers is connected in parallel and fed to the grid of V_{13}, the output cathode follower. The voltage divider in the grid circuit of V_{13} is

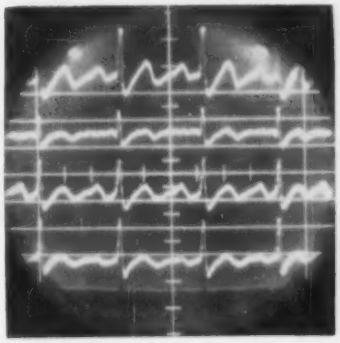

FIG. 4—Simultaneous four-lead electrocardiograph traces

adjusted so with positioning controls R_5, R_6, R_7 and R_8 set at the midpoint of their range, the voltage at the cathode of V_{13} is zero with respect to ground. The values given accomplished this result with the tubes used; other tubes may require a different ratio.

Modifications

To keep the frequency of the multivibrator independent of external capacitance effects at the synchronizing input connections, an isolating triode amplifier capacitance coupling a positive pulse to one of the grids of V_1 at point A would be a valuable addition to the circuit.

As it stands, the unit is a high-level switching device because of a 60-cycle hum pickup of approximately 0.001 volt. By using d-c on the filament of V_{13} this hum is greatly reduced, but not entirely eliminated. Direct-current filament power for all amplifier filaments would probably increase the utility of the instrument for low-level switching. Better shielding and placement of parts for shorter leads would also decrease the hum-pickup problem.

The amplifier section of the switch, consisting of V_9 to V_{13} and V_{14}, was tested for fidelity by applying a sine wave to one of the inputs, with gain wide open, and varying the amplitude until the output wave showed visible evidence of distortion on the oscilloscope. This was repeated at spot frequencies from 10 to 100,000 cps and the threshold of distortion, the amplitude of the input signal at which distortion just becomes evident, was plotted against frequency as shown in Fig. 2.

The channels may be used for measurement. For example, if channel 1 is to carry the signal, channel 2 can be superimposed on the zero-signal trace of channel 1 to mark the zero line. With the signal applied to channel 1, channels 3 and 4 can be moved to mark the positive and negative peaks as shown in Fig. 3. Subsequently a calibrated voltage applied to channel 1 could be adjusted to make channel 1 coincide with the peak marker. A time comb could also be applied to channel 2.

To date, the instrument has been used for measurement of peak potentials and for simultaneous observation of the four standard leads in electrocardiography as shown in the photograph and Fig. 4.

In Fig. 4, channels 1 to 4 are positioned top to bottom. Channel 1 carried the standard first lead (right arm against left arm), channel 2 the second lead (left arm against left ankle), channel 3 the third lead (right arm against left ankle) and channel 4 the fourth lead (chest against left ankle). This setup is shown in the photograph.

A word of appreciation is in order to Gordon Simkin, technical assistant, for his work on this project.

Automatic Colorimeter

SUMMARY —— Three-phototube measuring head with associated electronic equipment give readings of percent saturation on three meters marked red, blue and green. Can be used for quality control of color television picture tube production

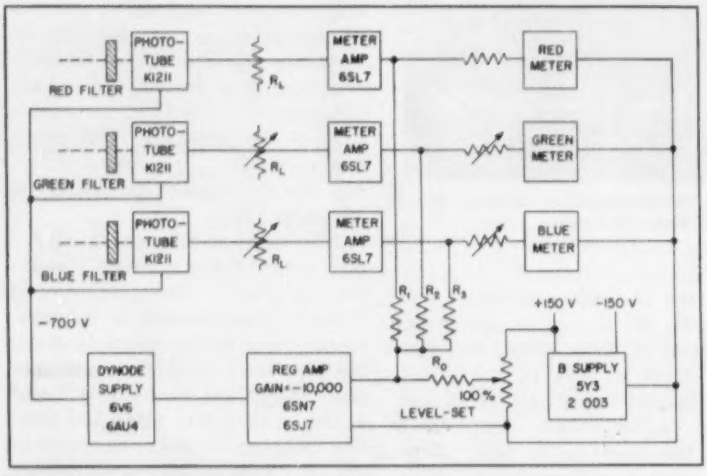

FIG. 1—Negative feedback is used to stabilize colorimeter against source brightness variations. Meters indicate primary color proportions

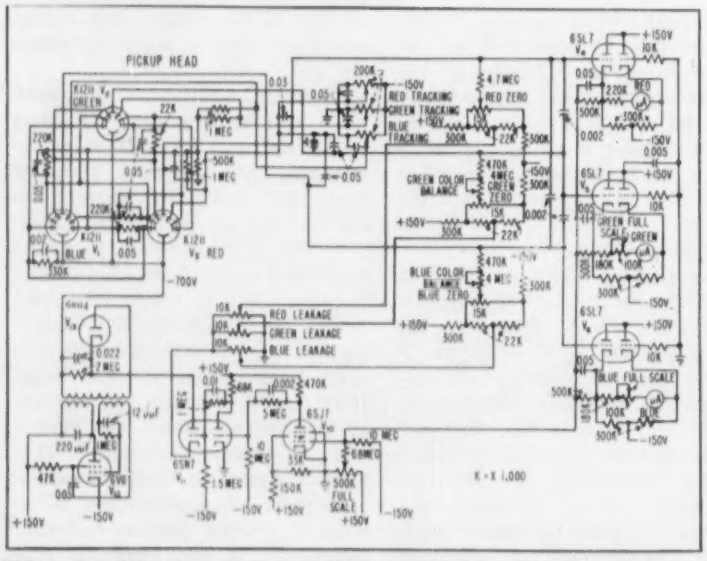

FIG. 2—Complete schematic diagram illustrates controls used to calibrate instrument with white light source

DEVELOPED primarily for checking tricolor television tubes by production personnel the colorimeter to be described imitates the color vision properties of the human eye. When the color pickup head is aimed at a luminous surface, its color content is analyzed and three meter indications are obtained within a second or so provided the surface brightness is sufficient.

Selectively energized through red, green and blue filters, the meter indications are a direct measure of the primary color proportions and numerically define the hue and saturation of the luminous source. Color comparison accuracy is good as time lapse between successive measurements can be only a few seconds. Source brightness within limits has a negligible effect on the indicated color proportions.

The pickup head is housed in an aluminum shell 6 inches long and 2 ¾ inches in diameter. The circular red, green and blue color transmitting filters are arranged in an equilateral triangle. The filters are of gelatin film cemented between 22-mm glass disks. They are fitted into blackened, undercut rims cut on end-capped aluminum shells enclosing three multiplier phototubes.

The K1211 miniature phototubes are six-stage dynode multiplier types having end-on cathodes of ½-inch diameter and S-11 photometric response. Cathode sensitivity is rated at 50 μa per lumen average response to a 2,870 K incandescent lamp. The amplified anode current

Checks TV Color Tubes

By EMIL SANFORD
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Color measurements are made by placing pickup head of colorimeter on face of operating tricolor tube and noting three meter readings

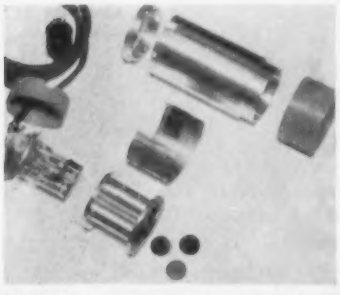
is an exponential function of the applied dynode voltages.

Since multiplier phototubes, with their built-in electrostatically focusing dynodes, are operationally disturbed by magnetic fields, the pickup head has a layer of Mumetal wrapped around the aluminum enclosures of the phototubes.

Operation

The operation of the instrument is explained by the block diagram, Fig. 1. Light striking the cathodes of the multiplier phototubes, through the respective color filters, causes current flow in each anode load resistor. The resultant voltages are a measure of the color composition of the light source and its brightness.

However a high-gain regulating amplifier and a fixed-voltage dynode power supply control the operating voltage applied to the parallel-connected phototube dynodes. The phototubes are gain controlled by a common signal. This signal is developed from the light-source intensity and automatically suppresses the brightness variations. The instrument thus responds only to the color composition of the light source.



Internal construction of pickup head showing filters, phototubes and circuitry

The phototube anode voltages are transferred to the indicating meters through cathode-follower meter amplifiers. From each point a sampling current is developed in R_1, R_2, R_3 whose sum is balanced against the adjustable current through R_4 of opposite polarity. The voltage at the junction of these four resistors is the input signal to the regulating amplifier. The amplifier has a reversed-polarity output to the dynode voltage divider and forms a negative feedback loop.

The meter voltage sum is thus constrained to a fixed value which is adjusted to exactly the full-scale value of one meter by the level-set control. Since the meters and phototubes are linear, each meter deflects to the relative excitation of its respective photocathode regardless of the common light intensity. The light level must be greater than a minimum threshold value or the full-scale sum cannot be maintained.

Whenever the input light level to the pickup head is insufficient to develop the total meter voltages to a level needed to equalize through R_1, R_2, R_3, the reference current in R_4, the amplifier stays saturated. The applied dynode voltages are maximum and the phototubes operate at maximum gain. An increase of the source brightness that would develop too much signal output is counteracted by the amplified difference voltage. The stabilizing ability when one or all phototubes are variably illuminated above the threshold value is: $\Delta E_m = \Delta E_d / A_o \approx 300/3{,}000 = 1/10$ v, where ΔE_m = indicating meter voltage variation for brightness changes, ΔE_d = dynode voltage swing with regulation against brightness changes $\approx$ 300 volts and A_o = effective loop gain $> 3{,}000$.

The meters contain 50-μa movements and with 220,000-ohm series resistors have a full-scale reading of 11 volts. Therefore, $\Delta E_m / E_m <$ 1/110 unit of full-scale error.

This is distributed among the three meter readings according to the chromaticity of the luminous source. Raising E_m would decrease the error and raise the threshold but caution is to be observed in

operating too closely to the knee of the phototube anode characteristic.

Circuit Details

The schematic diagram is shown in Fig. 2. The grid-cathode elements at the input of regulating d-c amplifier V_{10}-V_{11} develop a contact potential that cannot be distinguished from the control signal. A variation of 0.1 volt will cause a full-scale meter error of 3 percent. The 100-percent level-set control (labeled FULL-SCALE in Fig. 2) compensates for this effect.

The phototube anode load resistors are adjustable in the green and blue channels for setting gain relative to the red channel. Each anode load resistor returns through the meter zero-set controls. The three leakage compensating controls effectively complete the zeroing circuits. The leakage controls permit application of a canceling potential that maintains zero meter readings in the absence of light input to the photocathode despite dynode voltage variations.

Feedback Loop

The indicating meters are cathode-coupled to balance dual triodes V_4, V_5 and V_6. The green and blue meter series resistors are full scale adjusted to equal the full-scale red meter reading. The three 500,000-ohm summing resistors are tapped from each meter drive point to include the indicators in the feedback loop.

Even though the three K1211's, V_1, V_2 and V_3 are paralleled, a differential gain control condition is encountered. In practice, this would be interpreted as a color variation when only the incident brightness changed. At least two-point compensation is possible by the adjustment of the three tracking controls. These fix the voltage on the last dynode in each phototube.

Therefore, as the parallel connected forward dynodes approach the voltage levels of the last dynodes, the phototube with the highest fixed dynode voltage has the most gain reduction. The tracking adjustments are usually made to bracket the normal range of operating brightness levels. A white cathode-ray tube (P4 screen) with variable grid drive for changing brightness permits a simple checking procedure.

The dynode power supply V_{12} and V_{13} uses a relaxation oscillator to generate, in a stepup isolation transformer, a voltage which is then rectified and filtered. The 6AU4 is used for its heater to cathode insulation. Since the oscillator plate voltage is obtained from the stabilized ±150-volt supplies in the chassis, it is free from line-voltage fluctuation. It is limited to 700 volts to keep leakages in the multiplier phototubes at low levels.

Calibration

The zero-settings of the color indicating meters are made when the pickup head is placed face down on any nonluminous surface. The effective dynode voltages are at a maximum and the regulating feedback loop is broken during this interval. An unstable dynode supply can be the cause of zero shifts at this time which result in color reading errors.

The initial adjustments of this colorimeter were made with a white television picture tube. The final white color calibration can be made and maintained with a reference white working standard such as an incandescent lamp combined with a daylight glass filter. A crt was selected having a close match to illuminant C as measured on a Barnes XYZ colorimeter. For brightness data the Weston 931 foot-lambert meter was used. This meter has a circular opening only slightly smaller than the pickup head. The adjustments require the use of a calibrating plug. This is a shallow piston-and-rod unit that closely fits the open end of the pickup head and inserts to the bottom. A circular cutout permits, by rotation, the exposure of any one of the three filter-photocathode areas.

The picture tube is operated with a square raster and 100 foot-lamberts of luminous intensity. The pickup head is centered on the raster and the calibrating plug is sequentially positioned to expose the red, green and blue filters. For each position the 100-percent level-set, green full scale and blue full scale adjustments are made. In addition, the respective leakage adjustments are completed with an opaque sheet placed on the opening of the pickup head. The results should be full-scale on one and zero readings on two meters in turn.

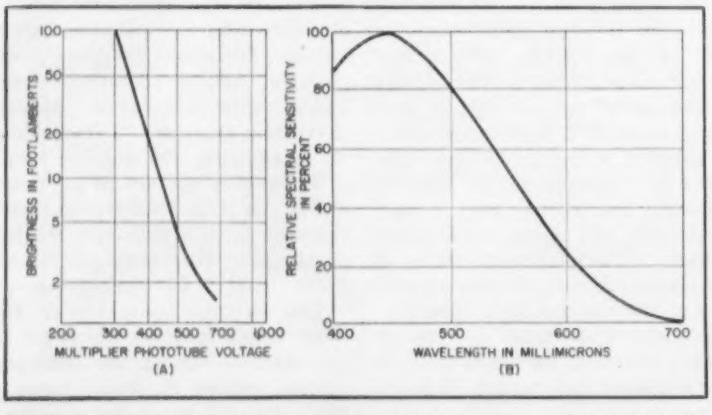


FIG. 3—Regulation of colorimeter shown by straight line above 5 foot-lamberts (A) and spectral response of K1211 phototube (B)

Color Balance

The color balance controls are set to fix the relative meter readings to the white color standard. For illuminant C, R = 29, G = 33 and B = 38 as the comparative offset to equal energy excitation, which is defined by R = G = B = 33⅓.

The three tracking controls are successively adjusted to maintain steady meter readings as the reference picture tube brightness is varied between 10 and 100 foot-lamberts. By reducing the brightness level to the point where the meter reading sum suddenly slumps, a check is made for the

threshold value of response.

The colorimeter's amplitude-regulating circuit attempts to maintain a constant value of meter readings. This is illustrated by the straight line to 5 foot-lamberts on the log-log plot of dynode feedback voltage versus source brightness, Fig. 3A. The color threshold is 1.5 foot-lamberts, which is low enough for ambient lighting to contaminate color indications. Below this level the meter indications are about proportional to the brightness and do not contain usable color information.

Theoretically the instrument could read color for all increasing brightness levels. But a limit is imposed by the K1211 photocathode at 10 microamperes peak emission. This is about the point where the current ceases to be a linear function of the incident light.

From the spectral sensitivity of the cathode, in Fig. 3B, the blue filtered phototube has the largest probability of limiting. A light source emitting energy equally throughout the spectrum would reach this limit with a brightness of about 1,000 foot-lamberts.

Filters

The photometric filters used are red = one red cellophane sample and one Wratten No. 86, green = two Wratten No. 102 and blue = one Wratten No. 48.

A Wratten No. 25 is also usable for the red filter even though its sharp cutoff for orange and yellow is not precisely suitable.

These filters provide high transmittance coincident with the desired spectral response when combined with the spectral sensitivity of the K1211 phototube. The resultant spectral discrimination of this colorimeter is shown by Fig. 4. The curves are established largely by the spectral characteristics of the phototubes, the availability of filter material, and the desire for high optical efficiency. The area under the red response curve represents about 5 percent of the K1211 unfiltered sensitivity to equal radiant energy.

The curves are based upon ICI mixture data for real spectral primaries and the condition for equal radiant energy response. They provide meter indications that read the percentage of red, green and blue colors in the luminous sample. These are directly transferable to an R-G-B diagram as shown in Fig. 5. Equal curve areas result in equal indications for an equal energy spectrum. The approximate spectral wavelengths are indicated around the edge of the triangle.

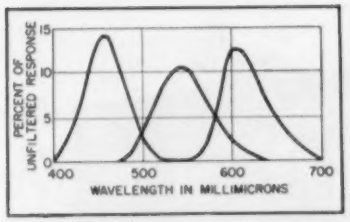


FIG. 4—Response of red, blue and green phototubes when balanced for equal meter readings and with an equal-energy spectral source

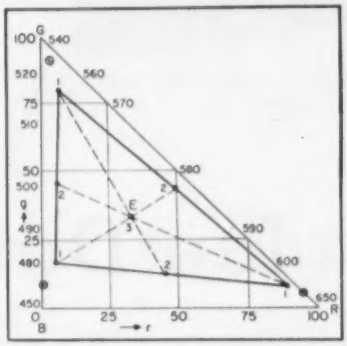


FIG. 5—Colorimeter indications recorded in R-B-G diagram for single-screen primary color phosphors (crosses) and same phosphors on a tricolor shadow-mask tube (line-connected dots)

The colorimeter responds to luminous excitation so that R + G + B = 100 percent where R, G and B each may be between 0 and 100 percent. White color is indicated by similar percentages on each meter. Equal energy white, the center of the triangle, is defined as color of zero saturation. The edges of the triangle define colors of maximum saturation with the corners identifying the pure primary colors. These are indicated, respectively, by two meters summing to 100 percent, one meter at zero, and by one meter totaling 100 percent, two meters at zero. The blue indicating meter is operationally unnecessary. It is retained for its convenience in operation and the monitoring of the 100-percent level.

The spectral acceptance of a similar instrument may be modified to the ICI distribution coefficients that permit color interpretation in the familiar XYZ form. This compresses the color information into a fraction of the R-G-B scale lengths. The reading accuracy is reduced for only real colors are available in any case. However, the double peaked x tristimulus function can be simulated by tying a resistor from the Z blue meter drive point to the X red phototube anode load resistor. This is effectively a unilateral signal so that no red peak is introduced into the z function.

The primary target of this colorimeter is a cathode-ray tube. The usual display is a tv raster of large area and medium brightness generated by a small moving spot of high intrinsic brightness. To the pickup head, this is an intermittent light with a low duty cycle. The resultant peak phototube currents greatly exceed the average currents to which the indicating meters respond. The short persistence of most phosphors does little to modify the peak to average brightness.

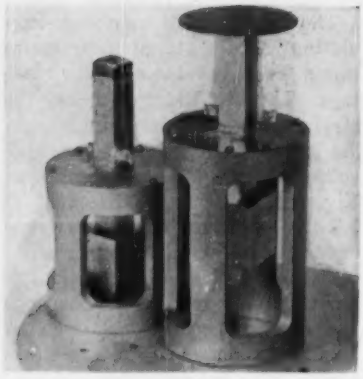
CRT Indicator

It is possible to use a cathode-ray tube as the color indicator. The deflection plates are cross-connected to develop 120-degree radial scan separation for primary color excitation. The display is in polar coardinate form on a circular grid with the radial and angular spot displacement identifying the quantities saturation and chromaticity, respectively.

In Fig. 5 the crosses record the hue and saturation of color tube phosphors as measured on single screen experimental cathode-ray tubes. The same phosphors, applied to a typical 19TP22 tricolor tube, have the measured hue and saturation as shown by the line-connected dots. Some tolerable desaturation of the display colors must be established. To fix these limits realistically, a measuring instrument of this kind is needed if every manufactured tube is to be checked.

The author acknowledges the work of Frank Kliminski in the construction of this instrument.

Indicating unit has provision for calibrating meter for three separate sensing units. Relay built into meter sets off alarm at preset ice-load level



Piezoelectric sensing unit shown in cross-section in Fig. 1

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Chicago, Ill.

Ice Detector for

ACCURATE determination of ice accretion on lighter-than-air craft is especially acute as the ice cannot be removed by any practical, self-contained means. The quantity of heat required to melt even a thin ice coating by heating and circulating the helium would be astronomical.

The system described here is designed to measure quantitatively the actual deposited mass per unit area as a primary variable. This is done by causing the accumulated ice mass to change the equivalent mass of a vibrating system and thus to alter its frequency of vibration. The change in the system resonant frequency is measured and a quantitative measure of the amount of deposited mass per unit area is thus obtained.

The system consists of three basic parts: the piezoelectric vibrating elements, the oscillator circuits whose frequencies are controlled by the piezoelectric elements and a frequency detector and indicating circuit.

This piezoelectric unit consists of two elements. One is cemented to the inside surface of the fabric which covers the top of the container of the unit so that the formation of ice actually adds to its equivalent mass. The other element is not in contact with the surface and is not affected by the formation of ice. This latter element acts as a frequency control unit against which the frequency of the sensing element can be compared.

Crystal Stacks

Figure 1 shows the construction used in the final model. The sensing element consists of four parts. The first is a tapered beryllium disk driven by an adp crystal stack. This driving stack is separated from the beryllium plate by a small quartz plate. Another quartz plate is affixed to the opposite end of the stack and to this is cemented a terminating equivalent quarter-wave aluminum bar.

The adp stack is made of four crystal slabs each 1½ in. by ½ in. by ½ in. giving a total stack 1½ in. by ½ in. by ½ in. The adp was chosen because it combines a good coupling factor with frequency stability. The use of the two quartz elements on each end of the stack provides two desirable effects. First, they dielectrically insulate the adp from the beryllium disk and terminating aluminum bar. Second, by splitting the quartz plate, the compliance in a plane perpendicular to the direction of motion of the crystal stack is increased. This reduces the tendency to clamp the end of the bar which would reduce the effective coupling coefficient and thus reduce the system sensitivity.

The vibrating element which is used as a reference is identical to the sensing element except for the beryllium plate which is replaced by a small piece of lead with a roughly equivalent mass. This element is then mounted in a similar fashion to that used for the sensing element but no portion of it is in contact with the cover on which the ice forms. The frequency difference between the sensing element and the reference element is therefore a measure of the deposition of ice on

*Work done while with Clevite-Brush Development Co.

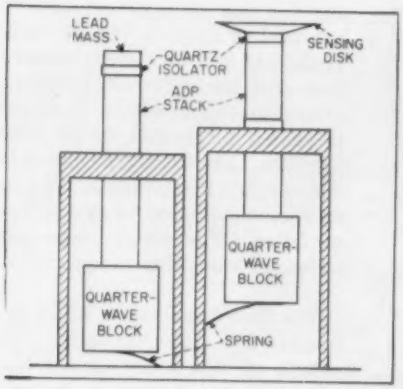
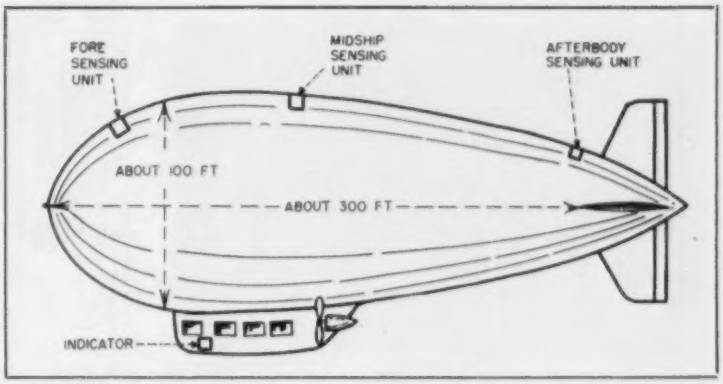


FIG. 1—Cross-section of piezoelectric stacks. Lead on top of reference stack approximates mass of sensing disk



Locations of indicator and sensing units on blimp. On preliminary test flights remote-control tv and motion-picture cameras were mounted on top of gas bag to monitor ice formation as a check on detector accuracy

Lighter-Than-Air Craft

SUMMARY —— Piezoelectric Meacham-bridge oscillator system determines ice accretion on surface of blimps. System also has applications in remote monitoring of ice formation on radomes and in automatic measurement of deposited coatings such as oil, grease or water

the former. Cold chamber measurements have shown that such a system effectively eliminates second order variables such as temperature and pressure.

A photograph shows the sensing and comparator elements as constructed in the first model.

Oscillator Circuits

The schematic diagram of the oscillator circuits is shown in Fig. 2. This circuit consists essentially of a Meacham-bridge oscillator wherein the nonlinear bridge element which is usually an electric light bulb has been replaced by a vacuum-tube agc circuit. The most severe problem that was encountered in the development of this circuit was that of obtaining satisfactory operation under conditions of low Q in the vibrating crystal system and over a large range of

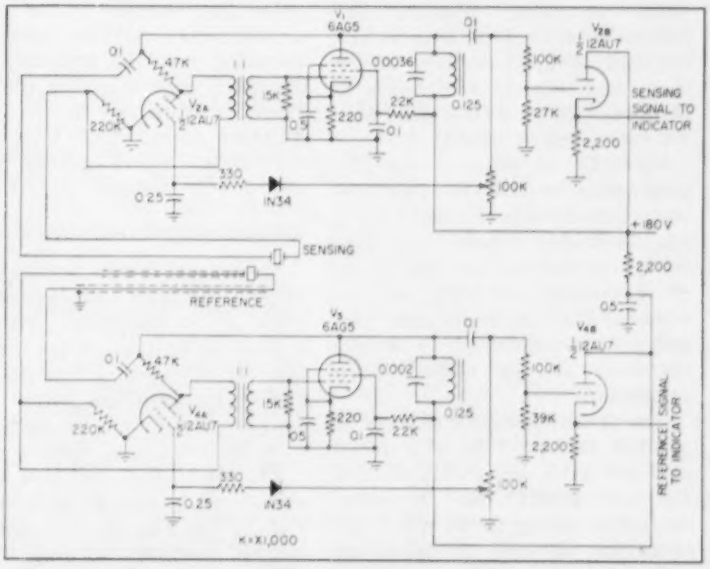


FIG. 2—Duplicate Meacham bridge circuits are used for sensing and reference. Triode in one leg of bridge functions as automatic gain control

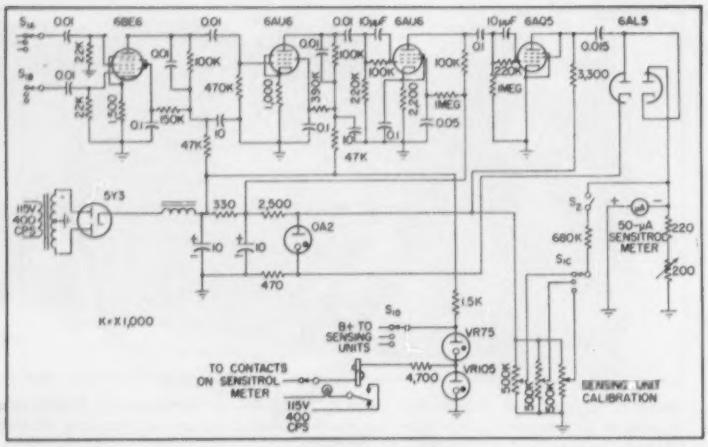


FIG. 3—Indicating unit is connected to either of three sensing units by switch S_1. Separate meter calibration is provided for each sensing unit

equivalent resistances. These two effects are, of course, intimately related and require the same circuit modifications for their accommodation.

In the normal Meacham-bridge circuit, the equivalent resistive impedance of the crystal element, when operating at its resonant frequency, is low, and therefore low-impedance elements can be used in the other arms of the bridge. In this application, however, the equivalent resistive impedance of the crystal was high and varied over a considerable range between unloaded and fully ice-loaded conditions.

The equivalent resistive impedance of the crystal without any ice load is approximately 20,000 ohms, and this value increases to between 80,000 to 90,000 ohms with full ice loading of 0.050 in.

Operation at spurious resonant frequencies of the vibratory system was avoided by the use of tuned circuits having a bandwidth wide enough to accommodate the range of frequencies occurring between unloaded and fully loaded conditions and yet narrow enough to exclude operation at any other system resonance.

The oscillator circuit consists of a 6AG5 vacuum tube with tuned grid and plate and grid excitation fed back through the frequency-controlling bridge circuit which embodies the vibrating crystal as one arm.

A portion of the output of the 6AG5 is rectified through a 1N34 diode and then applied to the control grid of one half of a 12AU7 which is inserted as a level control in the Meacham bridge.

The output is also fed to the grid of the other half of the 12AU7 which acts as a cathode follower providing a low output impedance to the long length of cable running over the surface of the airship from the sensing units on top to the indicating unit in the gondola. An identical oscillator circuit is provided for the reference crystal.

Although this circuit is basically simple and straightforward in design, extreme care had to be taken in the determination of the proper circuit values so that successful operation could be achieved with the low Q in the crystal vibrator. These modifications to the usual Meacham circuit should have other applications where similar problems are encountered.

Detection and Indicator Circuit

The sensing system produces two outputs, one from each cathode follower. It is necessary, therefore, to provide a circuit which will detect the frequency differences and display the resulting output in a manner which can be correlated with the amount of deposited ice.

The operation of this part of the system can be seen by reference to Fig. 3. The signals from the two cathode followers are fed into a 6BE6 multiple-grid mixer. The output of the mixer tube is passed through one stage of amplification provided by a 6AU6. The associated circuits of this tube are designed to pass only the difference frequency, as are subsequent stages. The signal is passed to another 6AU6 which provides additional amplification and effects a partial transition from sine-wave operation to square-wave operation. The 6AQ5 stage completes the transition to square-wave operation.

The final stage uses a 6AL5 as a counter-type discriminator. The output of this stage is fed to a microammeter having a sensitive relay which can be adjusted to flash a warning signal for any predetermined accumulation of ice up to 0.25 lb per sq ft.

Performance Characteristics

Operation from no ice loading to an ice loading of 0.25 lbs per sq ft has been achieved. The indicating meter has been calibrated to read directly in lbs per sq ft of deposited ice and experiments to date have shown that this calibration holds equally well for water films.

To date it has been possible to achieve reproducible indications of deposited ice within the basic accuracy originally desired (minimum measurable and reproducible increments of 0.010 in. of ice). The system is now undergoing flight tests at the Naval Air Development Station, South Weymouth, Massachusetts.

Further development will permit considerable extension of the dynamic range of the instrument and provide a safety device applicable to heavier-than-air as well as lighter-than-air craft.

Applications other than those involving use with aircraft include the remote detection and control of ice formation on radomes or other structures, recording of ice or frost for meteorlogical purposes and the automatic measurement and recording of any deposited coating, such as oil, grease, soft mud or water, which has reasonable adherence and which does not introduce damping beyond the present operating range of the instrument.

The work described in this article was sponsored by the Office of Naval Research under contract No. Nonr-1494 (00).

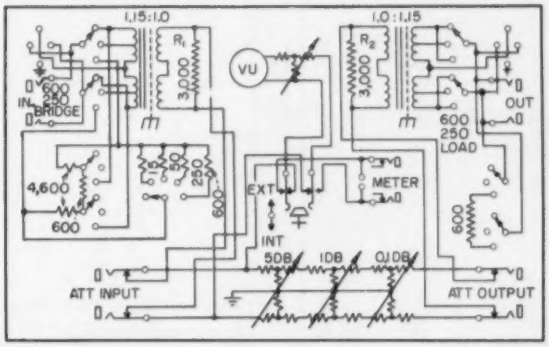
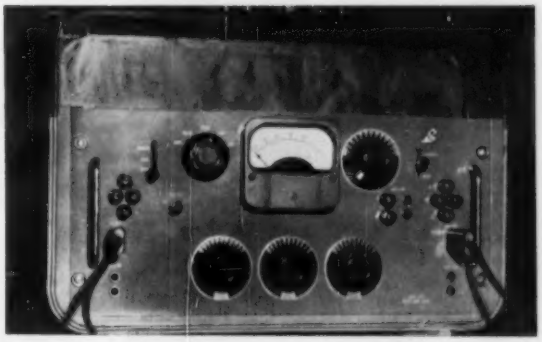


FIG. 1—Complete gain set has frequency response of 20 to 20,000 cps, ± 0.7 db when loading and ± 1.5 db when bridging



Gain set is housed in luggage case with breakdown hinges for removing cover. Case provides room for leads and accessories

Transmission Gain Set

SUMMARY —— Precision attenuator aids testing of a-m and f-m broadcast stations' audio facilities. Unit has total maximum attenuation of 63.5 db in steps of 5, 1 and 0.1 db. Minimum insertion loss is 2.5 db over frequency range of 20 to 20,000 cycles per second

By GERALD R. CHINSKI
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Radio Station KXYZ
Houston, Texas

AS AN AID to meeting increased need for better and faster measurement and servicing techniques for a-m and f-m broadcast stations, an audio-transmission gain set has been constructed.

The equipment is shown in the photograph and in the schematic diagram, Fig. 1. It is housed in a heavy-duty luggage case that has extra space for packing accessory cables and patch cords.

Circuit

The heart of the instrument is a precision variable balanced H-type attenuator having zero insertion loss and a maximum selective loss of 61 decibels. The individual elements, cascaded to form the attenuator, are three 600-ohm, 0.5-precent accuracy controls. These controls have, from left to right in Fig. 1, ten steps of 5 db per step, ten steps of 1 db per step and ten steps of 0.1 db per step.

The attenuator is capable of handling a maximum power level of about +55 dbm and the overall power level is +30 dbm. There is no frequency discrimination in the attenuator, even at maximum loss, out to 80 kc. The balanced attenuator is made directly available through break-in jacks.

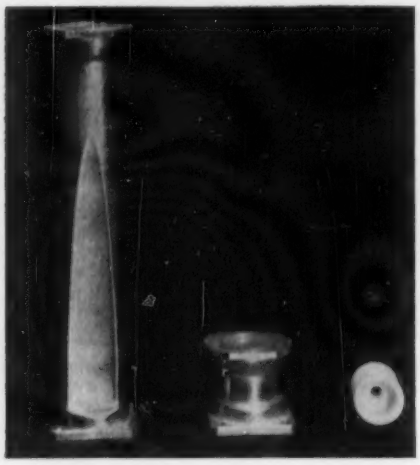
Overall input and output is provided by both jacks and instrument binding posts. Switching provision is made for input and output impendance matching at 600 and 250 ohms. A third position on the input selector key makes the input bridging at 9,500 ohms. This produces a fixed 30-db loss when fed from a loaded 600-ohm source.

In the bridging position power-loading resistors of values shown can be switched across the input terminals. This provides a handy arrangement for measuring amplifiers while being driven at high output. The output impedance selector key also terminates the gain set unit in 600 ohms when in the up position.

The end matching coils are excellent at low level and have no tendency to saturate at higher levels of the order of +30 dbm. They are well balanced and have 90-db magnetic shielding. Windings are arranged to cancel out externally induced electromagnetic fields and are provided with electrostatic shields between primary and secondary.

Resistors R_1 and R_2 build out the attenuator loading, so that the transformed impedance, at the input and output terminals, is close to the value selected and almost purely resistive.

The gain set is equipped with a standard vu meter, having a 1 mw in 600 ohms reference and a multiplier range of 24 db.



The conventional tapered transducer at left and the new stepped transducer, center, showing reduced size. Transformer dielectric insert is at right

By IRWIN D. OLIN
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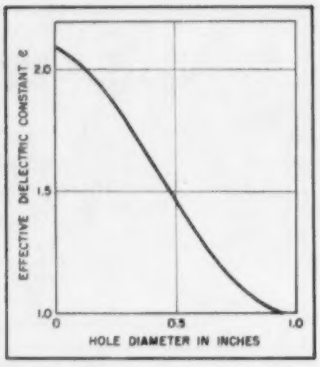

FIG. 1—Dielectric constant vs bore for a Teflon tube, 15/16 in. i/d, in a circular waveguide

Dielectric Transformers

SUMMARY —— Dielectric sections provide reflectionless match between differing waveguide impedance levels and maintain match over a broad frequency range. Dielectric version of conventional rectangular-to-circular waveguide transducer is 80 percent shorter and has improved performance

MANY PROBLEMS encountered in microwave transmission require impedance transformers to optimize system performance. This paper describes the application of dielectrics to dominant-mode circular-waveguide transformers. Two designs are presented both operating within the X-band from 8,500-9,600 mc and using 15/16 in. i-d circular waveguide.

The first design is a rectangular-to-circular waveguide transducer, a dielectric transformer which, when inserted in a circular waveguide, permits the rectangular guide to join it directly.

The second design is a pressure seal for circular waveguide. Seals of this type may be used to provide weather-proof protection of a waveguiding system or enable a section of guide to operate under pressure.

These designs use a transformer composed of dielectric sections to provide a reflectionless match between differing impedance levels and maintain this match over a broad frequency band.

The configuration of the matching transformer is arbitrary. It could be a section of smoothly tapered dielectric or it could be composed of dielectric steps. The problem of converting from one impedance level to another is approached through the use of intermediate dielectric sections of varying impedance levels.

The change in the amount of reflection introduced as a wave travels from one section to another describes this variation. This may be termed the reflection taper. The number of these sections is arbitrary, being finite for a stepped section (each section made one-quarter guide wavelength long at the design frequency) and tending toward infinity in the case of the smooth taper.

The solution which results in the most compact design is the stepped matching transformer. The number of steps employed and the reflection taper govern the bandwidth over which the match between the two impedance levels is maintained.

Binomial Taper

Assume n steps will be used (n-1 quarter-wavelength sections) in going from one impedance level to another. The reflection taper depends upon the reflection coefficient of each step in relation to an adjacent step. The reflection taper is given by 1, k_2, k_3, . . ., k_n.

One of the most satisfactory tapers which provides a broadband design is the binomial taper. The reflection taper corresponds with the coefficients in the binomial expansion. Thus for a three-step design (n=3) the reflection taper would be given by 1, k_2, k_3 = 1, 2, 1.

Several 15/16-inch o-d Teflon tubes about 5 inches long were

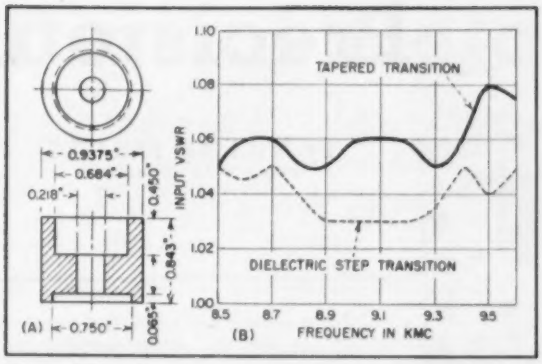

FIG. 2—Stepped transformer for the rectangular-to-circular waveguide transducer (A) and performance characteristics of new stepped transducer and conventional tapered transducer (B)

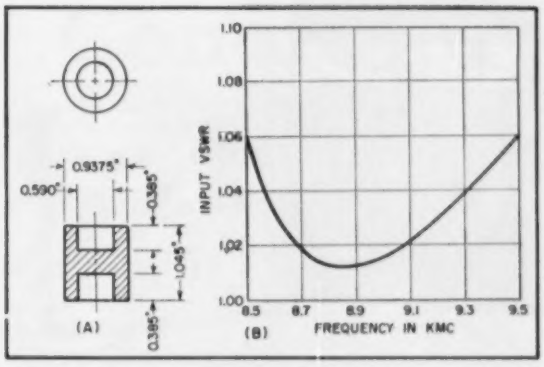

FIG. 3—Teflon pressure seal design for circular waveguide (A) and performance characteristic of the pressure seal (B) which provides weather-proof protection

for X-Band Waveguide

bored with varying inside diameters and a small longitudinal slot milled into the surface. The tubes were successively placed in a precision circular slotted line and the guide wavelength measured.

Using these figures and assuming only dominant mode transmission, a value of effective dielectric constant was computed for each tube. This value represents the dielectric constant of a material completely filling the guide and resulting in the same guide wavelength.

For a given tube several values were determined, one for each frequency at which measurements were taken. These values showed no appreciable variance, within the limit of experimental error. A curve of the effective dielectric constant versus the bore diameter of the tube was thus obtained, shown in Fig. 1. This curve gives all the information necessary to design Teflon dielectric matching sections in this size circular guide.

The transformer is circularly symmetrical, being composed of dielectric tubes. Hence it satisfies conditions for exciting the TE_{11} mode at any angle in the circular waveguide from the TE_{10} mode in the rectangular waveguide.

The problem reduces to providing an impedance match between the two waveguide sections. Since two different cross-sectional geometries are involved, the definition of waveguide characteristic impedance becomes ambiguous. However, by constructing transformers designed according to the different definitions, it was found that the definition based on power-voltage considerations gave the best results.

Stepped Design

A binomial stepped design was employed using three impedance steps between the impedance level of the two guides. All the calculations were referred to 9,100 mc. Due to the step-like nature of the design, a discontinuity susceptance is effectively placed at each abrupt change in dimension. If this change is small, compared to the waveguide dimensions, the overall performance will not be greatly different from that predicted.

In this design the following adjustments were made: the transformer was positioned 0.065 inch away from the circular-rectangular junction; the low-impedance section was lengthened; and its impedance slightly increased.

Note that since the junction is the place at which the change in cross section takes place, the coupling flanges used here contributed to the performance of the overall transducer. The rectangular wave guide was equipped with a UG 40A/U choke flange and the circular waveguide with a flat flange.

The completed design is shown in Fig. 2A and its performance illustrated in Fig. 2B. The same figure shows the performance of a typical tapered transducer designed to perform the same function.

The pressure-seal design is composed of a section of waveguide completely filled with a dielectric and some means for providing a broadband match to the adjacent unfilled waveguide. In this type of design, or in any design where only one waveguide cross section is involved, any choice of characteristic impedance definition will result in the same dimensions for the matching section. The design chosen for the matching section was a single binomial step. After slight modification the performance shown in Fig. 3B resulted. The dimensions for the design are shown in Fig. 3A.

The author wishes to acknowledge the contributions of P. J. Allen and R. D. Tompkins in the work described.

Precision

By WILLIAM PERZLEY
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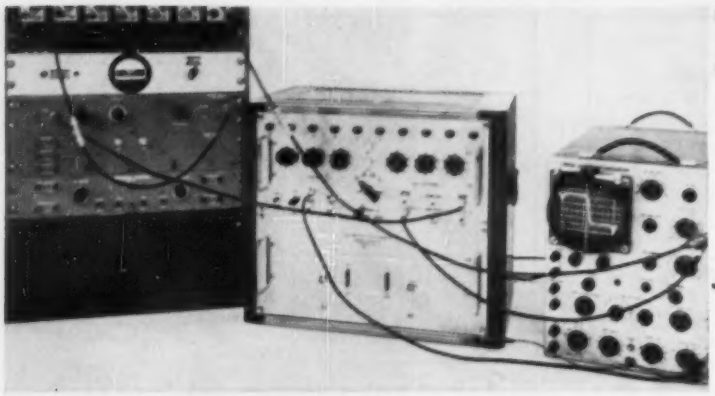


To make delay measurement, delay trigger 2 is fed to external sync input of crt. Initiating trigger goes through target simulator (left) to crt vertical input. One-microsecond markers are fed directly to crt vertical input

APPLICATION of digital-computer techniques to time-interval generation and measurement can provide a highly accurate generated delay and exact time discrimination.

The precision digital delay generator to be described gives as its output a reference pulse followed by pulses precisely delayed in time with respect to the reference pulse. It can supply these pulses under one-shot or variable frequency steady-state conditions. Its accuracy is determined by the frequency stability of a 1-mc crystal-controlled master oscillator, which is thermostatically controlled and accurate to one part in one million. Performance characteristics are given in Table I.

Figure 1 illustrates the output pulses available under steady-state conditions. In this mode, both t_1 and t_2 are independently controlled by their respective input dial settings. Figure 1B gives the output pulses available under one-shot conditions.

The ability to supply pulses accurately positioned, as shown in Fig. 1, makes the digital delay generator useful in radar and sonar range calibration and target simultation. In this application, the intiating trigger is used as the system trigger and delay trigger 1 at preset delay settings is injected as the simulated target. The process of calibration involves adjusting the range-measuring circuitry of the system to agree with the known target delay.

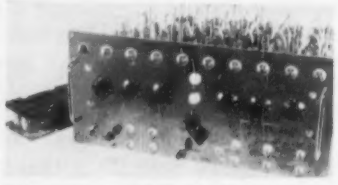
The technique used in delay measurement is to compare the delayed signal with signals of known delay generated by the delay generator, making a vernier measurement or interpolation with a synchroscope. The equipment setup is shown in the photograph.

Logic of System

The block diagram (Fig. 2), shows the 1-mc crystal-controlled oscillator followed by two cascaded divide-by-ten counters to provide three separate ranges of operation. Range 1 utilizes the 1-mc crystal output directly, range 2 uses the 100-kc output from the first divider circuit. Range 3 uses the 10-kc output of the divider. The unit provides an external input jack which will accept other standard frequency inputs.

The crystal-controlled master pulses of ranges 1, 2 or 3 are fed to a 10-stage binary counter. The stored count provides the time-measurement information which is used in the selection of a specfic input pulse. This is accomplished by diode gating circuits which are connected to the outputs of the binary counters through a manually controllable decimal-to-binary encoder. The arrangement makes it possible to set manually any count up to the maximum capacity of the binary counter 2^n where n represents the number of counter stages—and extract an output pulse, delay trigger 1, at that particular count for each cycle of the count chain. Any number of encoder-gate combinations can be used with a single count chain depending upon the number of controllable delay periods desired.

The unit has two selection gates. The first gate output provides a pulse, delay trigger 1, delayed with respect to the start of the cycle, while the second selection gate determines the period for cyclic operation. This arrangement allows maximum flexibility for a count chain of fixed length. The settings of both the first and second encoder-gating systems can be varied throughout the full count range if the second selection gate is set equal



Chassis of precision digital delay generator illustrating modular design

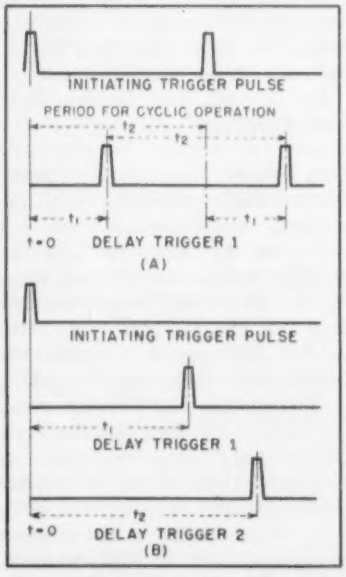


FIG. 1—Pulse outputs for cyclic operation (A) and one-shot operation (B)

Digital Delay Generator

SUMMARY —— Pulses for calibrating radar equipment and for target simulation are made available by instrument using 1-mc crystal oscillator and flip-flop frequency dividers. Precision of pulse timing is independent of flip-flop transition time

to or greater than the first.

The accuracy of the generated delay is not dependent on flip-flop transition time or length of flip-flop counter chain and consequently represents an improvement over conventional digital and analog methods of generating precise time intervals. The pulses from the crystal continuously sample the selection gates as well as pulse the count chain. There is sufficient inertia in the count chain so that the Mth pulse which sets the counter to M will not pass through the selection gate assuming that the output of the decimal to binary encoder is M. However, the $(M + 1)$th pulse will pass directly through the selection gate and be available without accumulative delay. This arrangement is one count off and is readily corrected by a one-unit compensation in the decimal to binary encoder. Its advantage is zero phase lag regardless of time delay setting.

Operation

Under steady-state conditions, the start button triggers the one-shot generator which in turn sets control flip flop 1. Control flip flop 1 gates the succeeding master clock pulse through gate 3. This gated pulse marks the start of the time cycle and is called the initiating trigger pulse. The initiating trigger pulse resets control flip flop 1 and sets control flip flop 2. Control flip flop 2 opens gate 4 which allows the succeeding clock pulses to flow into the count chain and sample the selection gates.

A recycling scheme enables the pulse selected by the second selection gate to reset the binary counters and cut off the input flow of

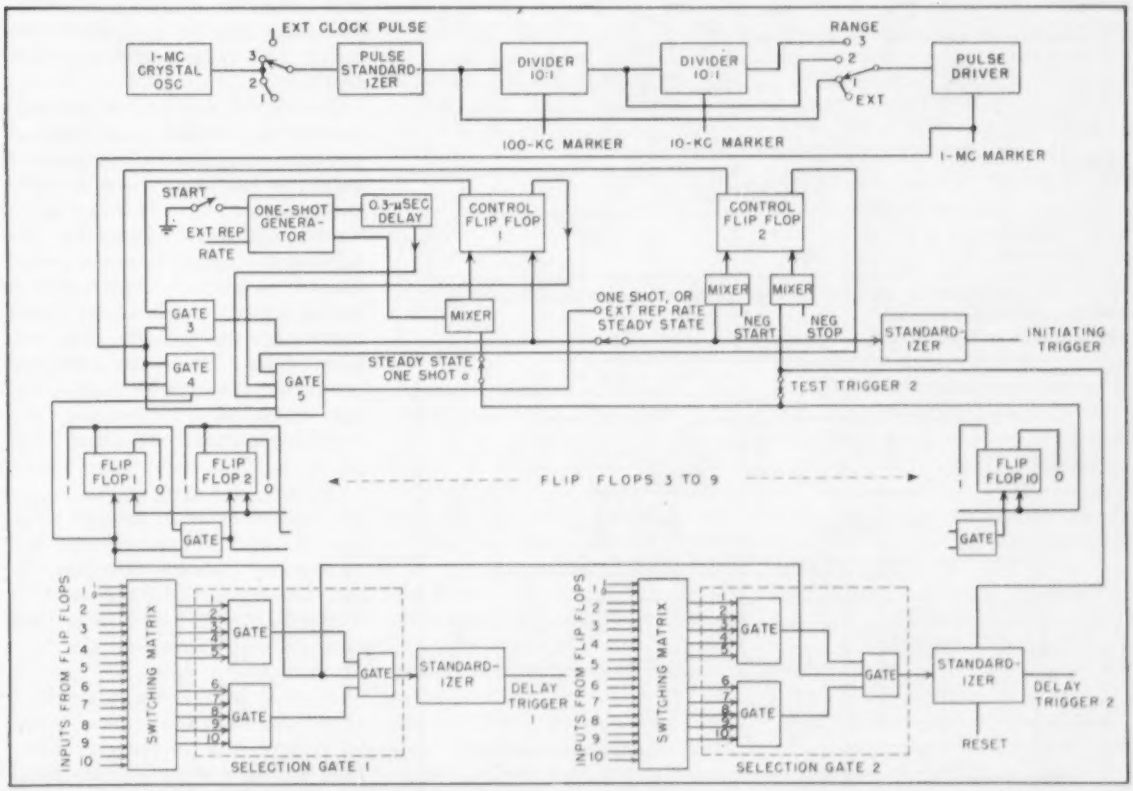


FIG. 2—Logical design of the precision delay generator and its de ailed operation may be traced from this functional block diagram. Crystal oscillator and counter chain provide three operating ranges

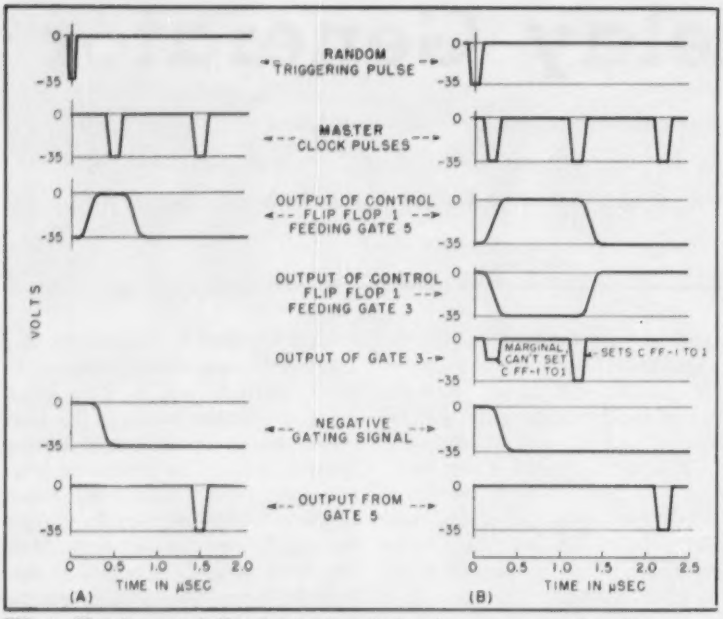


FIG. 3—Waveforms in buffer circuit when clock pulse occurs more than 0.3 μsec after trigger (A) and when clock pulse occurs less than 0.3 μsec after trigger (B)

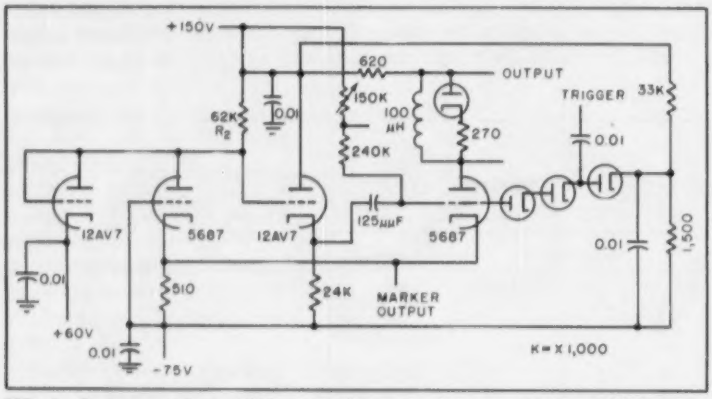


FIG. 4—One-megacycle to 100-kc count-down circuit is monostable multivibrator with common-cathode coupling

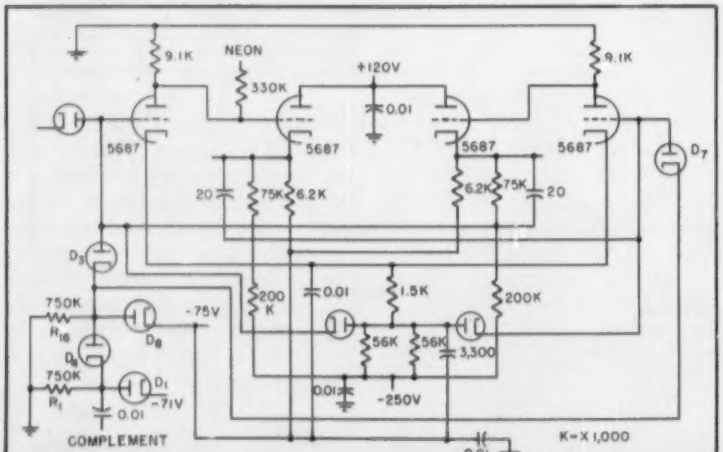


FIG. 5—One-megacycle binary counter is modified Eccles-Jordan flip-flop circuit

pulses by resetting control flip flop 2. This shuts gate 4. The pulse selected by the second selection gate sets control flip flop 1 to allow the succeeding pulse from the master clock to pass through gate 3 and set control flip flop 2. Control flip flop 2 then opens gate 4 and the cycle repeats.

Marker pulses are supplied for each of the three ranges. They are in time synchronization with the selected pulses from selection gates 1 and 2. The marker pulses are useful when making delay measurements with an oscilloscope.

Should the total count available in the chain be insufficient to yield a low enough repetition rate for a specific test, an external repetition rate source can be used to provide increased delay time.

One-Shot Operation

When operating asynchronously, one-shot or with external repetition rate control, the two selection gates are so set that selection gate 2 is higher than selection gate 1. The external trigger pulse hits the one-shot generator, resulting in a trigger pulse applied to control flip flop 1. This pulse sets control flip flop 1.

Control flip flop 1 gates the succeeding master clock pulse through gate 3 to reset itself. The one-shot generator also generates a negative gating signal which is first delayed by 0.3 microsecond, time for the flip flop to change state, and then applied to gate 5. The negative gating signal is delayed to insure that control flip flop 1 has had sufficient time to reach the 1 state to insure keeping gate 5 closed to the first clock pulse succeeding the initiating external repetition trigger pulse. This could occur within 0.3 microsecond after application of the random external trigger. The gate is unprimed during this 0.3-microsecond interval, this, plus the fact that control flip flop 1 will hold it closed until the next master clock pulse arrives, insure that the master clock pulse gated by gate 5, whether it be the second or third pulse succeeding the random external trigger, will be full amplitude. This technique eliminates marginal operation. The first master clock pulse after $t = 0$ may or may not

pass through gate 3 and reset control flip flop 1 but the second master clock pulse will most certainly do so. Should the first clock pulse reset control flip flop 1 the second clock pulse will pass through gate 5, setting control flip flop 2 and mark the start of a new count cycle. The arrangement described functions as a buffer between the two random control frequencies insuring error-free operation. The instantaneous repetition interval resulting can vary as much as one cycle of the master clock rate per count cycle. This represents a repetition frequency variation of less than 1 part in 1,000. Figure 3 indicates two possible timing diagrams for the buffer.

Self-Checking Feature

The unit is capable of checking essentially all its own circuits.

The unit is placed into operation in the one-shot mode. The output from delay trigger 1 is fed back into the negative stop terminal of control flip flop 2. The start button sets the unit into operaton and master clock pulses flow into the count chain as well as sample the selection gates. When the count reaches a value equal to one less than that set on the delay trigger 1 input dials, selection gate 1 is primed and the succeeding master clock pulse is gated out of delay trigger 1. Feeding this pulse back into control flip flop 2 immediately resets control flip flop 2, which in turn shuts gate 4. The count chain now stores the number which had previously been set on the input dial. The stored count can be read at front panel from neon indicators. Any disagreement indicates that there has been a system malfunction. The same procedure can be used to check the delay of delay trigger 2. For this test, the system functions as it normally would in the one-shot mode, except that the front-panel switch test trigger 2 is thrown, which opens the reset line to the count chain thereby retaining the accumulated count. Testing the system under one-shot conditions is generally more severe than under similar steady-state conditions.

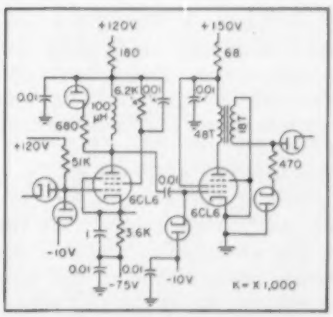


FIG. 6—Pulse standardizer

Circuits

The internal circuitry operates in straight binary using negative pulses throughout. The signal amplitude required for triggering all regenerative circuits is -10 volts. A combination of d-c and capacitive coupling incorporating d-c restoration is used throughout.

The 10-to-1 divider circuit given in Fig. 4 is a modified monostable multivibrator incorporating common-cathode coupling. Clamping of the plate swing of the normally cut-off tube and the grid swing of the normally conducting tube provides for stability of operation. The circut utilizes a cathode follower within the plate-to-grid feedback loop which isolates plate load R_p from the interstage capacitive loading. This provides rapid recovery as well as large output swing resulting in a stable count down from 1-mc to 100-kc. A similar circuit is used for the 100-kc to 10-kc count.

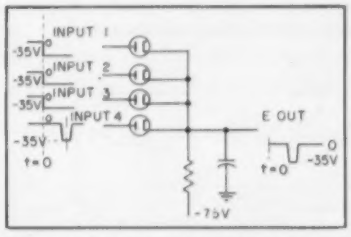


FIG. 7—Diode coincidence circuit

The 1-mc binary counter given in Fig. 5 is a modified Eccles-Jordan flip flop so designed as to provide a high degree of reliability. The circuit employs cathode followers within the plate-to-grid feedback paths providing a high output voltage swing at high switching speeds since the capacitive load is driven by the cathode followers. The flip flop employs cathode stabilization insuring satisfactory operation with half-emission tubes. The grid swing is clamped at both ends, removing all grid recovery problems. Complementing is accomplished by driving both flip-flop grids negative simultaneously through isolation diodes D_3 and D_7. The negative in the complement pulse passes through the d-c restoration clipping circuit composed of R_{11}, D_1, D_4, R_{12} and D_8 where the most positive 4 volts of signal is clipped. This provides immunity to spurious signals under 4 volts in amplitude.

The pulse-standardizer circuit given in Fig. 6 is composed of two cascaded 6CL6's. The first stage consists of a conventional cathode-stabilized amplifier with plate ringing circuit wherein a positive standardized output pulse is generated for each negative input trigger. The output pulse is further amplified and shaped by the normally cut-off output tube. The output circuit is transformer coupled to the load and operates in the bottom portion of its plate characteristic thereby effectively clamping the output pulse amplitude.

Gating is accomplished with diode coincidence circuits of the type shown in Fig. 7. Proper design can insure zero delay in gate output when coincidence is detected.

Table I—Performance of Delay Generator

Accuracy of Generated Time Intervals	
Range	Accuracy
0–1,000 μsec	better than ±0.002 μsec
0–10,000 μsec	better than ±0.01 μsec
0–100,000 μsec	better than ±0.1 μsec

Accuracy of Delay Measurement*	
Range	Accuracy
0–1,000 μsec	±0.03 μsec
0–10,000 μsec	±0.3 μsec
0–100,000 μsec	±3.0 μsec

Secondary Standard Pulse Rates	
Range	Formula for Freq in cps
0–1,000 μsec	$\sum_{n=1}^{1,000} 1/n \times 10^{-4}$
0–10,000 μsec	$\sum_{n=1}^{1,000} 1/10n \times 10^{-4}$
0–100,000 μsec	$\sum_{n=1}^{1,000} 1/100n \times 10^{-4}$

* Using Tektronix 514AD or equivalent osc.

High-Quality Receiver

SUMMARY —— Off-the-air pickup of television signals for commercial rebroadcast requires features often lacking in modified home receivers. Article describes how a set especially designed for rebroadcasting attains operational reliability, immunity to interference and proper video i-f response

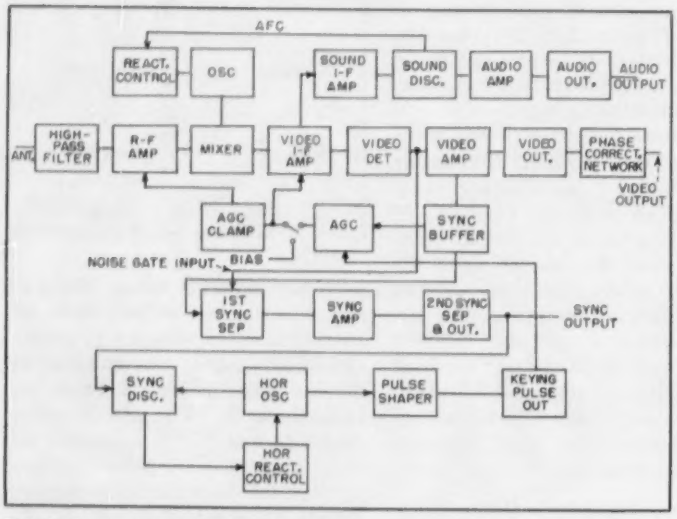
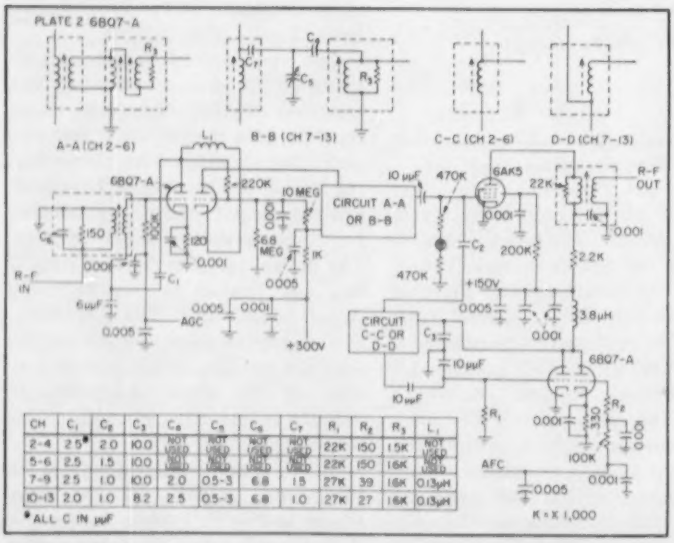


FIG. 1—Receiver incorporates automatic frequency control of local oscillator for greater frequency stability



CH	C_1	C_2	C_3	C_4	C_5	C_6	C_7	R_1	R_2	R_3	L_1
2-4	2.5*	2.0	100	NOT USED	NOT USED	NOT USED	NOT USED	22K	150	15K	NOT USED
5-6	2.5	1.5	100	NOT USED	NOT USED	NOT USED	NOT USED	22K	150	16K	NOT USED
7-9	2.5	1.0	100	2.0	05-3	6.8	15	27K	39	16K	0.13μH
10-13	2.0	1.0	8.2	2.5	05-3	6.8	1.0	27K	27	16K	0.13μH

*ALL C IN μμF

FIG. 2—Plug-in front ends are designed for optimum performance at frequency of desired channel

By RAYMOND S. ROSENBERG

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SEVERAL STATIONS engaged in direct pickup and rebroadcast of television signals have modified home tv receivers to meet their needs.

Some requirements of a tv receiver for commercial rebroadcast operation have been found lacking in modified home-type receivers. These requirements include: reliability in terms of uninterrupted service, accessibility of all components, interference immunity to high-level signals at the antenna and to strong radiated signals at the intermediate frequency, correct video i-f response, stabilized local oscillator and low audio harmonic distortion with proper receiver frequency response.

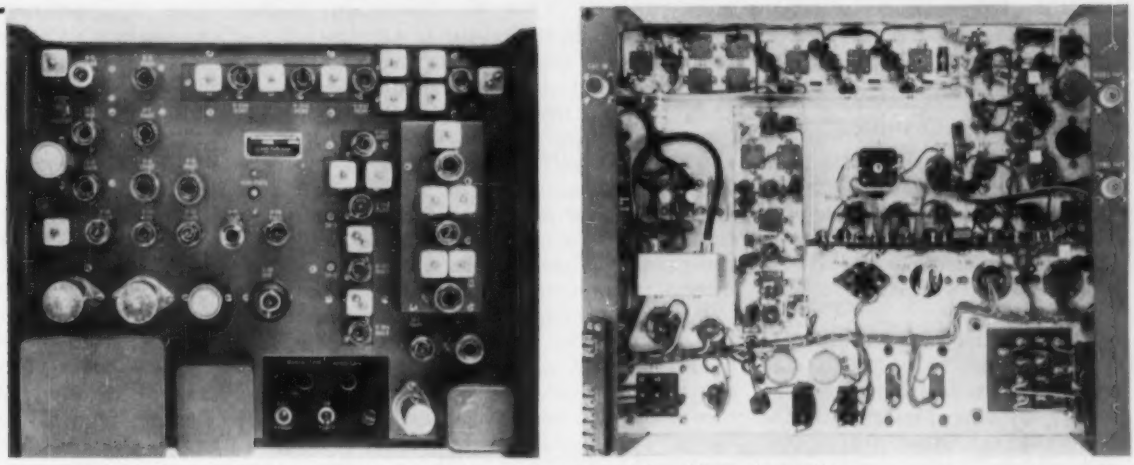
Front and rear views of a television receiver designed for commercial rebroadcast sevice are shown in the photographs. Figure 1 is a block diagram.

Front End

Each front end (Fig. 2) is a complete subassembly which plugs into the main chassis. This construction eliminates moving contacts and optimizes circuit constants for each channel.

One-half of a 6BQ7A serves as a modified Colpitts oscillator, the other half as the control tube for afc. The reactance tube utilizes the internal capacitances of the tube and resistor, R_2, as the grid phase-shifting network. The value of

for TV Rebroadcasting



Front and rear views of television receiver for off-the-air pickup. Set is designed for rack mounting

R_s used is a function of the operating frequency and is selected for maximum frequency control. Resistor R_s loads the oscillator tuned circuit and its maximum value is limited by the plate dissipation of the local oscillator.

Included as an integral part of the receiver is a high-pass filter. The filter has greater than 50-db rejection at 21 mc and eliminates interference due to strong signals received at the intermediate frequency and prevents overload of the first r-f stage by high-power a-m broadcast and other low-frequency emissions. The response of the filter is shown in Fig. 3A.

Accessory Filters

To eliminate cross-modulation interference in high-signal areas, accessory high- and low-pass filters were developed. Both have appreciable attenuation in the f-m band. The response curves are shown in Fig. 3B.

Figure 4 is a schematic of the rest of the receiver.

Particular attention was devoted to producing an overall response that did not appreciably change with agc level and to producing the proper low-frequency slope with a minimum number of tuned circuits.

The mixer plate circuit on the tuner chassis is link coupled to a tuned circuit in the grid of the first i-f amplifier forming a double-tuned transformer. The secondary of this transformer is inductively coupled to the first sound trap (21.25 mc), which also provides the signal source for the 21.25-mc sound i-f amplifier.

An M-derived filter network is used between the plate of the first and the grid of the second i-f amplifier. This network contains two traps, one tuned to 21.25 mc for additional sound rejection, the other tuned to 27.25 mc, the adjacent picture carrier frequency.

The first and second i-f stages are gain controlled. Cathode compensation of input capacitance variations with bias is used.

The last three i-f stages form a flat staggered triple with a flat-top bandwidth of 3.75 mc.

The first stage, due to the M-derived filter structure in its plate, will not respond to screen neutralization, and for this stage a 6AU6 with its low grid-plate capacitance was selected.

The desired video i-f response, in particular the critical low-frequency slope, has been produced in only two stages of the receiver. The wide bandwidth of the r-f circuits

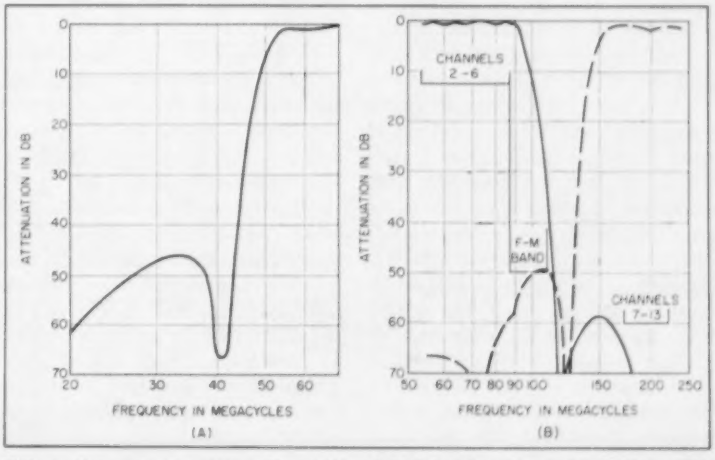


FIG. 3—Response of antenna filter (A) and high-band and low band filters (B)

and of the flat staggered triple prevents these stages from materially affecting the overall response.

Figure 5 shows the overall video i-f response from antenna to video detector. The response is flat to 3.75 mc with usable response to 4.0 mc. Markers occur at 22, 25, 25.75 and 26.5 mc.

Other Circuits

The sound i-f consists of a high-gain voltage amplifier with 300-kc 3-db bandwidth driving wide-band cascade limiters followed by a phase-shift discriminator with 0.75-mc peak separation for low distortion.

The aural signal is available at output impedances of 600 or 150 ohms, balanced or unbalanced.

For optimum performance the combined television transmitter and receiver characteristic must produce a linear phase system.

The low-frequency cutoff amplitude slope of an ideal receiver as shown in Fig. 6 affects the carrier and the upper and lower sidebands for ±0.75 mc from center, introducing a serious source of time delay. This delay is maximum at 0.1 mc and decreases to zero at approximately 2.5 mc.

Attenuation in the region of 4.0 to 4.5 mc gives rise to serious time delay beginning at 2.5 mc and increasing with frequency. An all-pass phase-correcting network suitable for compensation of this delay is so complex as to make its inclusion in home tv receivers impractical. Attenuation of the sound carrier must occur ahead of the second detector to prevent mixing of the sound and video information and, in the case of color, the sound and color subcarrier, which would produce a 920-kc beat. Beat interference produced at the second detector cannot be trapped in the video amplifier.

Phase Compensation

Figure 7A is a horizontal sync pulse taken from the coaxial cable feeding a television transmitter.

Figure 7B is the same pulse viewed with a diode double sideband detector sampling the transmitter final r-f output before it is fed to the sideband filter. No phase compensation of any type was employed at the transmitter, and therefore for these tests the transmitter did not conform to the NTSC standards.

The pulse of Fig. 7A has acquired a spike on the leading edge in passing through the transmitter. The pulse shown in Fig. 7C was taken from the output of the rebroadcast receiver with its phase-correcting network removed. The r-f input was double sideband and was taken from the transmitter coaxial line ahead of the sideband filter. The transient distortion of this pulse is serious and is entirely due to uncompensated delay produced by the low-frequency cutoff characteristic of the receiver.

Figure 7D was made under the same conditions as Fig. 7C with the

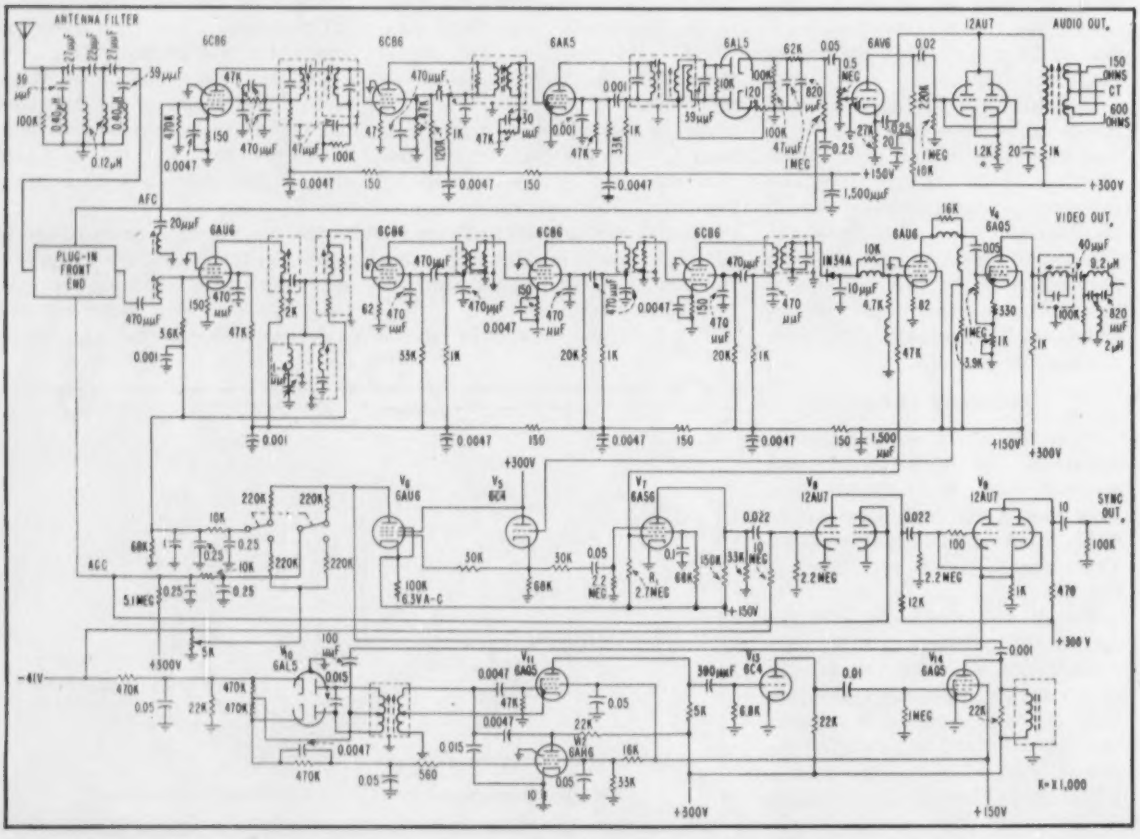


FIG. 4—Main receiver chassis includes aural, video, sync and 700-v horizontal sync pulse channels

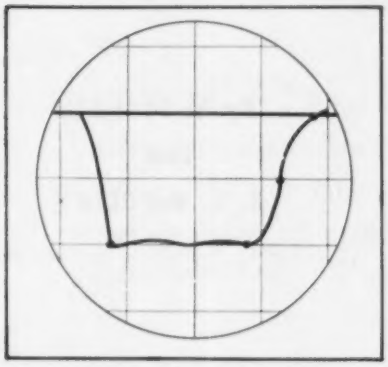


FIG. 5—Overall video i-f response

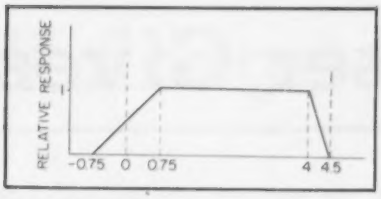


FIG. 6—Ideal receiver response

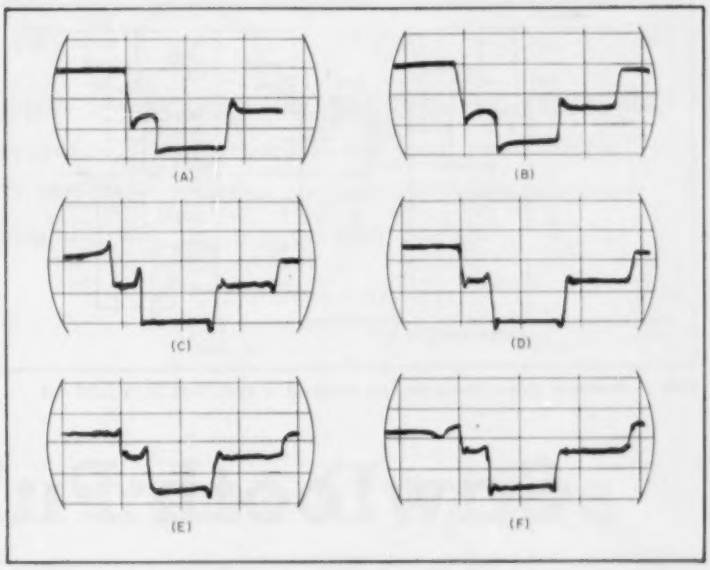


FIG. 7—Horizontal sync pulse into transmitter (A) and same pulse at double sideband detector (B). Pulse at output of receiver with phase-correcting network removed and double sidebank input (C)—same pulse with network in place (D). Single sideband pulse without (E) and with (F) phase-correcting network

addition of the all-pass phase-correcting network in the receiver. Compared with Fig. 7B it shows that almost perfect compensation has been achieved.

Figure 7E is the response of the receiver without phase compensation to a single sideband transmission. Comparison of Fig. 7E with Fig. 7C shows no increase in transient distortion due to uncompensated delay caused by the transmitter vestigial sideband filter. It appears that the most serious source of transient distortion in the television system is uncompensated delay introduced by the low-frequency cutoff characteristic of the video i-f amplifier.

Figure 7F is the response of the receiver with normal phase compensation to a single-sideband transmission. Compared with Fig. 7D, the same receiver with double-sideband input, the effect of the transmitter sideband filter is negligible.

Sync Amplifier

Tube V_7 is a 6AS6 dual-grid sync separator with the composite input signal applied to the suppressor grid. The control grid is connected to the video detector output. On large amplitude noise bursts there is sufficient voltage of negative polarity at the detector to cut off V_7 and prevent the suppressor grid from drawing current and setting up a bias. Under normal operating conditions, however, there is insufficient voltage available at the detector to overcome the clamping action produced by the current through R_1 and the control grid to cathode. Voltage amplifier V_8 operates at fixed bias derived from the −41-volt supply. Tube V_8 consists of both halves of a 12AU7 connected in parallel and plate coupled to the sync output connector. Sync positive pulses are obtained at the cathode to drive the horizontal sync discriminator.

To obtain a high-voltage pulse to operate an agc system, it is necessary to build a horizontal oscillator with synchronizing circuits, a waveform shaper and a pulse power amplifier. Tubes V_{10}, V_{11} and V_{12} form a horizontal sync circuit. Tube V_{11} is an electron-coupled oscillator operating at 15,750 cps.

criminator, V_{10}. The output of the tube connected across the oscillator tuned circuit and controlling its frequency in response to a control voltage obtained from the sync discriminator, V_{10}. The output of the oscillator is differentiated and amplified in V_{12}. The signal voltage on the grid of V_{12} drives it beyond cutoff and produces a sharpened pulse. Power amplification takes place in V_{12}. An output pulse of greater than 700 volts is obtained in synchronism with the horizontal sync pulse in the video amplifier.

Keyed AGC

Tube V_9 provides a keyed agc voltage. Composite video is applied to the control grid and a high-voltage pulse is applied to the plate. These two voltages appear simultaneously and an output is produced proportional to the grid voltage.

The agc voltage is connected through a divider circuit to the first and second video i-f grids. A delay circuit is connected in the agc line to the front end to prevent application of agc voltage to the r-f stage until the signal has built up to such an extent that noise is negligible. The keyed agc circuit minimizes picture degradation due to impulse noise and is effective in reducing flutter and rapid fading produced by reflections from aircraft. The highest flutter frequency the receiver will handle is 90 cps.

The author acknowledges the contributions of Ralph E. Grimm, chief engineer of Nems-Clarke, Inc.

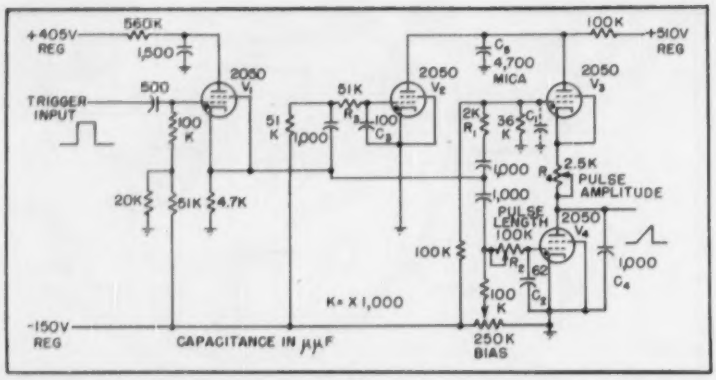


FIG. 1—Sawtooth pulser circuit may be triggered at rates from 50 to 5,000 cps

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Sawtooth Pulser Gives

VOLTAGE-CURRENT characteristics of circuit elements may often be obtained by d-c methods involving the measurement of the voltages across the element and across a standard resistance in series with it. Drawbacks of this, however, are polarization effects, heating effects and the need to make point-by-point plots.

The polarization effects can be avoided by using pulses or a-c with periods shorter than the polarization time. By using a-c and employing the well-known technique whereby the V and I outputs are used to deflect the beam of an oscilloscope along perpendicular directions, the characteristic curve may be obtained as an oscilloscope trace.

Unfortunately, however, in many cases the characteristic obtained is sensitive to the local temperature of the element and this may depend on the Joule heat dissipated in the specimen. In these cases it is imperative to use pulse techniques, the Joule heating being reduced in proportion to the smaller time that the voltage is impressed on the specimen.

Circuit Requirements

To retain the convenience of obtaining the characteristic as a trace on a scope, it seemed desirable to carry over to pulse measurements the techniques customarily used with a-c. This can be achieved by using a pulse whose amplitude is a well-defined function of time over the desired voltage range. The exact waveform of the voltage variation supplied to the specimen is unimportant as long as the pulse voltage and current outputs from the test circuit are synchronized.

To obtain traces of uniform brightness and to cover the voltage range in a monotonically increasing fashion, a sawtooth pulse voltage is used. To minimize Joule heating it is desirable to use both as short a pulse and as low a repetition rate as possible. As a check on the possibility of thermal effect, it is useful to be able to change the repetition rate easily, since thermal effects can be identified by their dependence on the repetition rate.

These conditions are satisfied in the equipment to be described. It provides a sawtooth-shaped pulse output whose repetition rate is determined by the frequency of the external trigger generator. The trigger frequency may be varied from 50 to about 5,000 cycles per second. This is conveniently accomplished with a Hewlett-Packard model 212A pulse generator.

The length of the output pulse is variable from about 0.2 to 5 microseconds while the pulse amplitude extends over a range of voltage from 0 to about 300 v. Additional d-c bias may also be applied in series with the pulses to extend the voltage range.

Circuit Operation

The circuit is made up of four tetrode thyratron tubes whose operation may be understood by referring to Fig. 1. Tube V_1, triggered externally, produces a standard pulse with a fast rise time and several hundred volts amplitude.

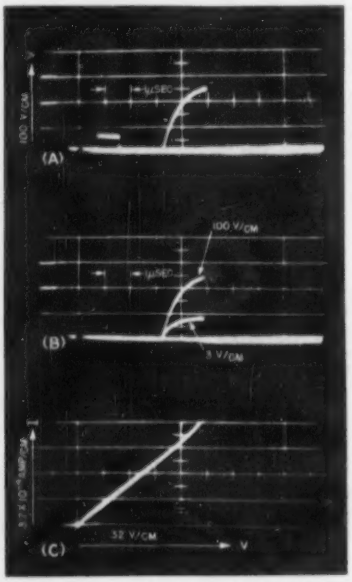

FIG. 2—Example of curves obtained for 100,000-ohm component, with 1,000-ohm resistor in series to give measure of current for vertical plates of scope

SUMMARY —— Four-thyratron circuit triggered by external variable-rate pulse generator makes it possible to display complete voltage-current characteristics of a wide range of circuit elements on an oscilloscope screen. Reverse characteristics of germanium diffused junction rectifier are shown as one example of use

Voltage-Current Curves

This standard pulse is fed by parallel paths to the control grids of V_2, V_3 and V_4.

The arrival of the pulse at the control grid of each tube is determined by the delay introduced by an integrating network consisting of a resistance and capacitance in the grid circuit of each tube. The standard pulse, after being delayed by $R_1 - C_1$ where C_1 is the stray circuit capacitance to ground, causes tube V_2 to fire. The cathode of V_2 is thus raised to approximately the plate potential of 510 volts as stored on C_2. This action produces a constant-amplitude pulse on the cathode of V_2 which is fed through the integrating network $R_4 - C_4$ to produce on C_4 a single sawtooth wave which is the output pulse.

The zero time of the output signal is determined by $R_1 - C_1$. After a delay determined by $R_2 - C_2$, V_4 fires, lowering its plate potential, and discharges C_4 to approximately ground potential, thus terminating the output pulse. Variation of R_2 adjusts the lengths of the output pulse.

The standard pulse, also having been fed through integrating network $R_3 - C_3$, then fires V_3 to completely discharges C_3, and resets the thyratron tubes by lowering their plate potentials below the extinction point.

The time delay introduced by $R_3 - C_3$ is approximately 5 microseconds, which limits the maximum length of the output pulse. The amplitude of the output pulse is determined by the value of R_4 which adjusts the time constant of $R_4 - C_4$ and thus controls the voltage rise on C_4.

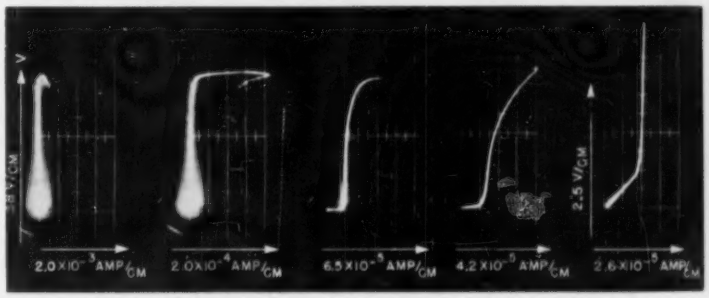

FIG. 3—Example of curves obtained for type 1N92 germanium rectifier when tested with five different values of resistance in series

In the load circuit, if the series resistance is made small compared to the element resistance, then the total voltage across the combination is approximately the voltage on the specimen while the voltage across the series resistance is the measure of the current.

Resistor Curves

When using the sawtooth pulser on a 100,000-ohm test element in series with a resistance of 1,000 ohms, the triggering rectangular input pulse and the resultant approximate sawtooth output are as shown in Fig. 2A. The voltage outputs obtained from the total combination and from the series resistance are shown in Fig. 2B. Figure 2C shows the resultant traces when the voltage and current outputs are applied to the horizontal and vertical axes of the oscilloscope.

Crystal Diode Curves

In Fig. 3 the apparatus was used to obtain the reverse characteristic of a GE 1N92 germanium diffused junction rectifier. By changing the value of the series resistance, it was possible to look at different regions of the curve in detail.

The equipment described here dissipates less power in the test specimen than that previously described by Pankove; series resistance and repetition rate are readily varied, and time or hysteresis effects are essentially eliminated.

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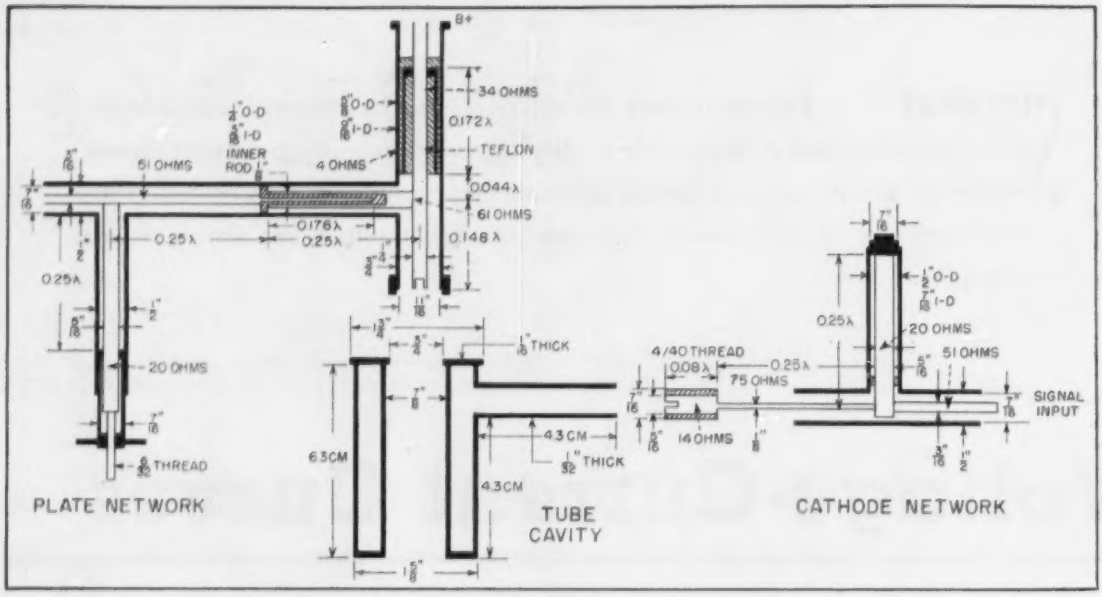

FIG. 1—Details of wide-band amplifier showing plate network, left, tube cavity, center, and cathode network, right

Wide-Band Amplifier

SUMMARY —— Low-noise r-f amplifier for uhf receiving equipment provides a 5 to 10-db gain in the 1,000-mc region, a bandwidth better than 200 mc and 51-ohm input and output impedances. Amplifier uses a 416B planar triode. Detailed design procedure is given

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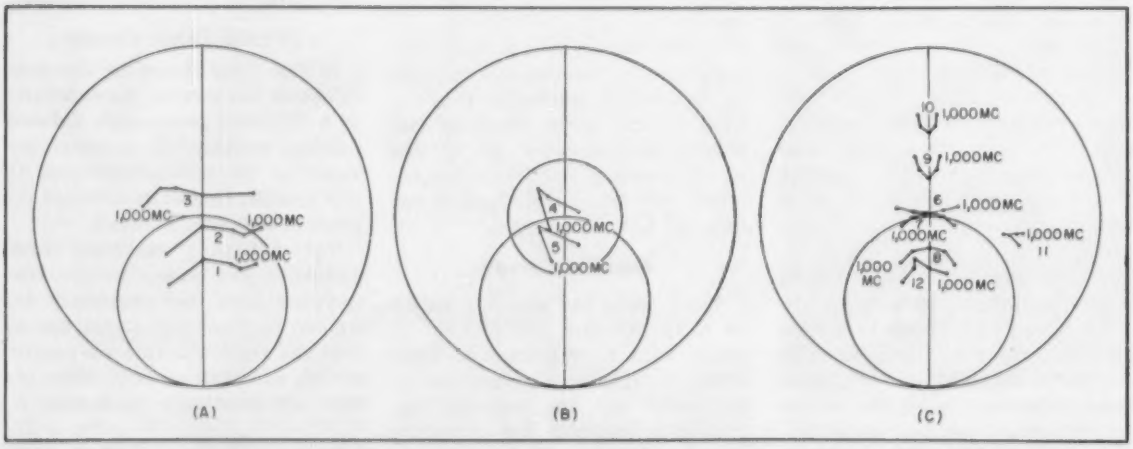
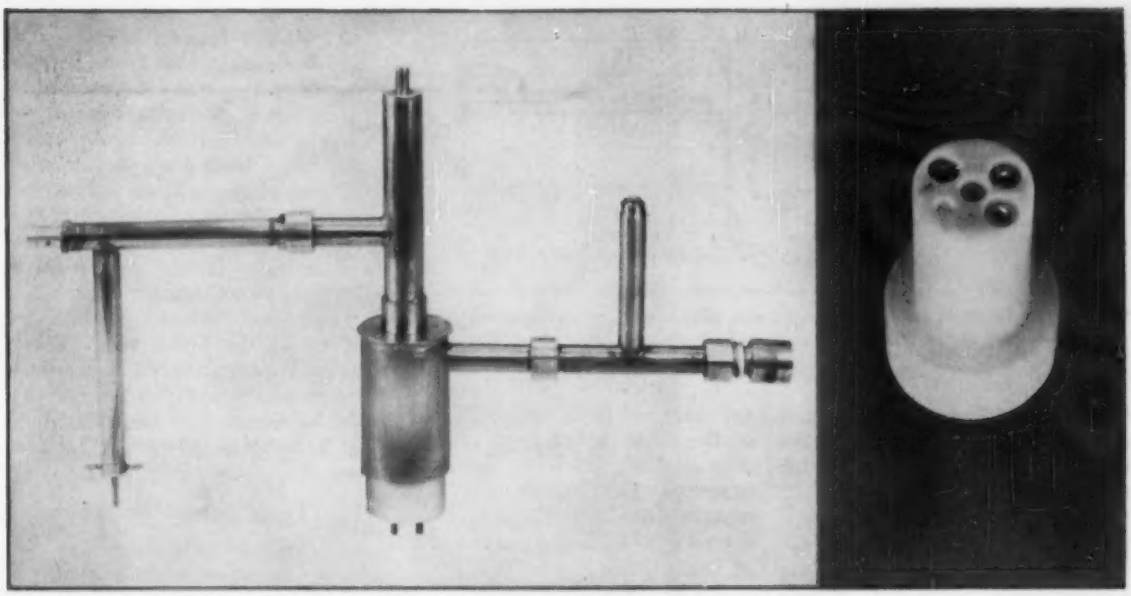


FIG. 2—Smith chart curves showing values of impedance at various points in cathode network (A and B) and in the plate network (C.) Plotting points on curves designate 50-mc steps from 1,000 to 1,200 mc



Wide-band uhf amplifier. Special Teflon tube socket for 416B planar triode is shown at right

for UHF Receivers

IN UHF receiving equipment it is often desirable to have a low-noise, wide-band r-f amplifier.

For one particular application it was necessary to have such an amplifier operate in the 1,100-mc region with a bandwidth of 200 mc, a gain of 5 to 10 db and an input and output impedance of 51 ohms.

Several types of tubes were investigated and it was decided that the 416B planar triode would be most suitable.

Perhaps the most outstanding feature of the 416B is its transconductance, 50,000 μmhos for a plate current of 30 milliamperes. This high value of g_m is obtained by using close grid and interelectrode spacing and tight tolerances.

Other characteristics of the 416B are: amplification factor 200, plate resistance 4,000 ohms and plate current 30 ma at 200 volts. One objectionable feature is the heat generated by the tube: about 7 watts from the filament and 6 watts from the plate.

Since it was desired to match the input of the 416B to a 51-ohm signal source, the cathode impedance of the tube under grounded-grid conditions had to be determined. The tube cavity, which provided for measuring the cathode impedance, is shown in Fig. 1, center.

From previous measurements it was known that the cathode had an inductive reactance component. A shunt capacitor with a 14-ohm impedance was inserted in the input line immediately at the cathode shell of the tube. This capacitor served not only to add a capacitive reactance component but also offered a point from which the input network could be designed.

Measurements

Values of cathode impedance were measured with a slotted line between 1,000 and 1,200 mc and are shown by curve 1 of the Smith chart, Fig. 2A. This plot is at 51 ohms since that is the characteristic impedance of the slotted line.

A satisfactory match between the cathode of the 416B and a 51-ohm signal source was obtained using a quarter-wave transformer and a quarter-wave shorted stub in the input network, also shown in Fig. 1 (right).

The quarter-wave transformer was made by transforming the impedance at the input side of the shunt capacitor from 51 ohms to 75 ohms (curve 2, Fig. 2A) and moving one quarter wavelength toward the generator, curve 3. At this point, a quarter-wave shorted stub was shunted across the line causing the arms of the curve to fold inward, curve 4. This result is then transformed back to 51 ohms, curve 5. Moving away from this point along a 51-ohm line revolves the points on the curve about the center of the chart.

From curve 5 it can be seen that the effective load resistance presented by this network varies from 56 ohms to 89 ohms. However there is actually only about an 8-percent change in the power developed across the load resistance.

The circle shown in Fig. 2B represents a voltage standing wave ratio of two. Curve 5 lies within this circle showing that the voltage

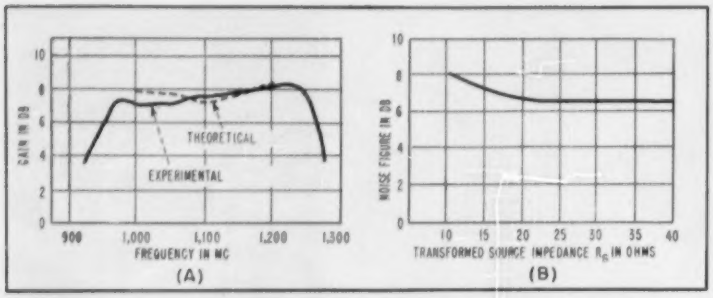


FIG. 3—Gain in db versus frequency (A) and noise figure versus transformed source impedance ($R_s = 1/G_s$)

standing wave ratio of the input network is less than two over the band from 1,000 to 1,200 mc which is adequate.

Output Network

Before the design of the plate network could be started, it was necessary to determine the impedance of the plate of the 416B under operating conditions by using the slotted line for frequencies from 1,000 to 1,200 mc. These values of impedance were found to range from $7.3 - j\ 104$ ohms for 1,000 mc to $0.9 - j\ 79$ ohms for 1,200 mc.

After the values of plate impedance had been determined, a network was designed which would match the tube to a 51-ohm load and keep the value of equivalent series resistance presented to the plate of the 416B reasonably constant. This network consisted of a quarter-wave shunt stub, a quarter-wave series capacitor, and a quarter-wave choke as shown at the left in Fig. 1.

The graphical representation of the operation of the network can be seen on the Smith chart, Fig. 2C. Starting from the 51-ohm load and moving any distance along a 51-ohm line has no effect on the impedance at any frequency. Therefore, the impedance at the shunt stub is a pure resistance of 51 ohms. This can be represented by a point at the center of the chart $1 + j0$.

At the point where the shorted stub joins the line, a shunt reactance is injected which spreads the points out from the center of the chart, curve 6. Moving from this point toward the generator along the 51-ohm line a distance equal to one quarter wavelength at 1,100 mc rotates the curve half way around the chart and tends to fold the arms of the curve in slightly, curve 7. Also at this point there is a series capacitor. The impedance of this capacitor has little effect upon the overall impedance and can therefore be neglected.

The values of impedance are next transformed from 51 ohms to 33.5 ohms, curve 8, which is the impedance of the outside shell of the series capacitor. Moving along the 33.5-ohm line one quarter wavelength rotates the curve another 180 deg around the chart causing the arms to fold in somewhat more, curve 9.

Connection to Tube

At this point the 33.5-ohm line joins the 61-ohm section of line which attaches to the tube. There is also a quarter-wave choke on this line which is placed such that it reflects an open circuit at the point where the 33.5-ohm and the 61-ohm lines join. This makes it possible to apply B+ to the 416B plate without allowing any signal to travel into the power supply.

Moving from the junction of the 33.5-ohm and 61-ohm line, curve 10, down to the tube a distance of 4.04 cm, moves the points on the chart about 0.150 λ toward the generator, curve 11. These values of impedance are then added in parallel with the impedances presented by the plate of the 416B to obtain the total impedance, curve 12.

In curve 12 (Fig. 2) the values of equivalent series resistance presented to the plate vary between 104 and 131 ohms. The average value for the five frequencies is about 120 ohms. The variation from 120 ohms is about ±10 percent and satisfactory.

To supply filament voltage and cathode bias to the 416B, it was necessary to construct the special tube socket shown in the photograph. Since there is a considerable amount of heat dissipated by the filament, Teflon was chosen as the socket material.

To block any r-f on the filament or cathode leads, quarter-wave chokes were constructed using polystyrene and pressed into holes drilled in the Teflon plug. These chokes have spring clips attached to one end which will engage the pins on the base of the tube when the Teflon plug is inserted into the base of the tube cavity.

Experimental Results

The response of the amplifier was determined experimentally using an input signal between 925 and 1,275 mc from a 51-ohm signal generator and a 51-ohm bolometer load on the output.

For an input of 1 mw, the output averaged about 5.7 mw over the band between 1,000 and 1,200 mc. This average is in close agreement with the calculated average of 6 mw.

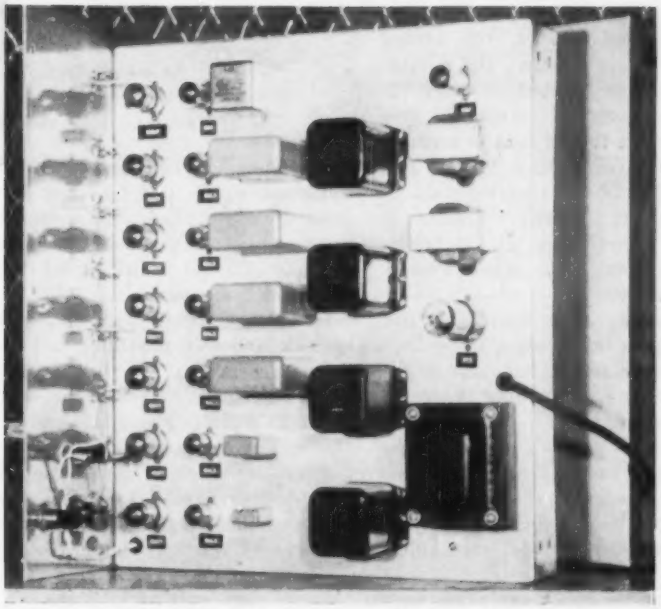
The overall response was flat within ±0.6 db as compared with the theoretical value of ±0.5 db. It can be seen from the graphical representation shown in Fig. 3A that the 3-db bandwidth is over 300 mc.

The noise figure of the first model wide-band amplifier, constructed from brass rod and tubing, was measured using a fluorescent tube noise source which had an output of 16.4 db above *KTB*. The resulting value of noise figure was 11.9 db.

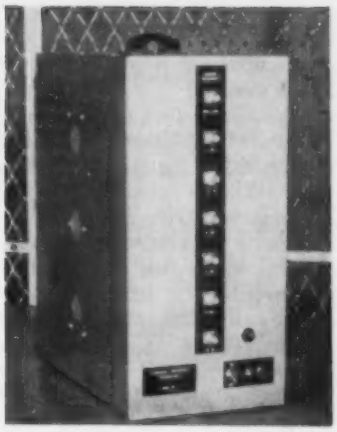
A second model was constructed which was a duplicate of the first except that all of the brass parts were plated with 0.001 inch of silver. The noise figure of this unit was 10.0 db, or an improvement of about 2 db over the brass model.

Although the noise figure of the silver-plated model is 2 to 3 db above theoretical, it is still satisfactory since the theoretical noise figure is difficult to realize at this frequency.

A view of the completed amplifier is shown in the photograph.



Top view of chassis showing physical layout of components



Complete generator showing outputs

By PETER KOUSTAS

Tube Division
Radio Corporation of America
Harrison, New Jersey

Audio-Standard Generator

SUMMARY — Simultaneous output voltages are available at frequencies of 500 cps, 1, 1.5, 2, 3, 5 and 10 kc from unit employing tuning-fork standard. Technique involves full-wave rectifiers as doublers to achieve desired frequencies

CALIBRATION of sensitive test equipment often requires an accurate source of audio frequencies.

For example, the pulse-repetition frequency of pulsed-magnetron test sets must frequently be calibrated by means of a high-quality audio generator.

When a wide range of harmonically related frequencies is desired, a crystal-controlled oscillator utilizing multivibrator-type dividers is often used to furnish an output at submultiples of the crystal frequency.

This article describes a less complex and less expensive experimental unit which features tuning-fork frequency control, relatively simple circuitry, reliability and elimination of the need for adjustments. Seven triode sections are used as cathode-follower output stages and all frequency multiplication is accomplished by diode doublers.

Frequency Control

The tuning fork is a frequency standard comparable in stability and accuracy to the quartz crystal.[1,2] Mechanically resonant reeds may also be used for frequency control with a slight sacrifice in accuracy. These mechanically vibrating elements are useful as the frequency-determining portion of an electron-tube oscillator such as that used in the standard audio-frequency generator described in this paper.

Oscillator-frequency control elements of the resonant-reed and tuning-fork types are readily available for any frequency in the lower audio range. The accuracy of commercial units ranges from 0.1 to

0.001 percent; higher values of accuracy are available on special units, depending on the characteristics desired.

The tuning-fork or resonant-reed controlled oscillators are electrically equivalent to the Meissner r-f oscillator.[3] This is shown in Fig. 1. The frequency of the r-f oscillator is determined primarily by the circuit within the dotted lines, which is composed of L_1, L_2, L_3 and C_1.

This circuit may be considered as a transformer whose primary and secondary, L_1 and L_2, are coupled through a high-Q resonant circuit composed of C_1 and L_3. If there is little coupling from L_3 to L_1 and L_2, the frequency of oscillation is approximately equal to $1/2\pi\sqrt{L_3C_1}$ and is substantially independent of external circuit parameters. Examples of these are tube capacitance or plate voltage.

Operation

In the tuning-fork oscillator, however, the transformer is physically quite different, although electrically equivalent. The primary and secondary are separated and not mutually coupled. One leg of a tuning fork made of magnetic material forms the core material of each coil.

Plate-current disturbances of any kind, such as those which occur when voltage is applied, have two simultaneous effects: the tuning fork is set in motion; and a magnetic flux is induced in it by the coil whose core it forms. Because a well-made tuning fork is mechanically equivalent to a high-Q resonant circuit, it vibrates only at its resonant frequency when shock excited. The loaded Q of a tuning fork can easily be made greater than 10,000.

When the tuning fork is excited, both legs exhibit some movement. The motion of the leg used as the core of the grid winding induces a voltage in the coil L_2. The circuit will then oscillate, provided the polarity of the grid voltage is such that it reinforces the plate signal and the tube supplies enough gain to offset circuit and mechanical losses.

Because feedback can occur only when the tuning fork is vibrating, the accuracy and stability of the oscillator depend directly upon the mechanical properties of the vibrating element.

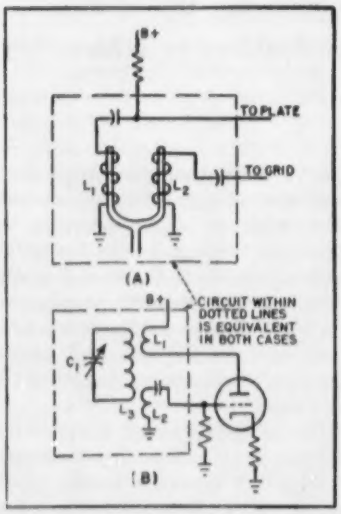


FIG. 1—Schematic diagram of tuning-fork-controlled oscillator (A) and Meissner r-f oscillator (B)

Circuit

A complete schematic of the standard-frequency generator is shown in Fig. 2. Triode V_1 is the tuning-fork-controlled master oscillator from which all output frequencies are derived. A small amount of negative feedback, provided by resistor R_1, limits the gain of the oscillator tube. Thereby the tuning fork is prevented from being overdriven and the purity of the waveform is improved to an appreciable extent.

The oscillator operates at a frequency of 500 cycles per second. This frequency was arbitrarily chosen because lower frequencies can be calibrated against the power-line frequency by Lissajous figures[4] observed on an oscilloscope. This technique may also be used to extend the usefulness of the standard-frequency generator down to 100 cycles or up to a frequency of 100 kilocycles.

Multiples of the base frequency are obtained by principles which are commonly known but not often applied to this particular application. The first four terms of the Fourier expansion of the full-wave rectification of a sine wave will result in the following expression

$$e = \frac{2E_m}{\pi} - \frac{4E_m}{3\pi}\cos 2\omega t - \frac{4E_m}{15\pi}\cos 4\omega t - \frac{4E_m}{35\pi}\cos 6\omega t$$

This expansion includes a second harmonic equal to $4/3\pi$ times the peak voltage applied. The presence of this second harmonic may be used to provide multiples of the oscillator frequency.

One half of twin triode V_2 is a cathode follower providing a low-impedance output at the fundamental frequency; the other half is an amplifier. The plate load of the amplifier consists of a transformer in which a center-tapped secondary provides a phase difference of 180 degrees between the voltages at the two ends with respect to ground.

Rectification

Diode V_3 is a full-wave rectifier. The original sine wave is thus converted to the familiar output waveform of a full-wave rectifier having a resistive load which is rich in harmonic content. The high-Q parallel-tuned circuit included in the diode load eliminates all harmonics except the second. The unloaded Q of the inductors used in this circuit ranges from 120 to 200.

An isolating resistor in series with the tuned circuit maintains a high loaded Q by minimizing d-c through the inductor and equalizes the amplitude of all frequency generator outputs.

The filtered second-harmonic voltage is then fed into a second twin triode, V_4. One triode amplifies the second harmonic in preparation for the next diode frequency doubler; the other triode provides another low-impedance cathode-follower output stage.

Frequency doubling provides only frequencies which are $(2)^n$ times the oscillator frequency, where n is an integer. Often, however, frequencies such as 3, 6 or 10 times the fundamental frequency are required. Two methods of achieving such frequencies were considered. The sine wave could be shaped to a form, such as a square wave, containing odd harmonics and then filtered.

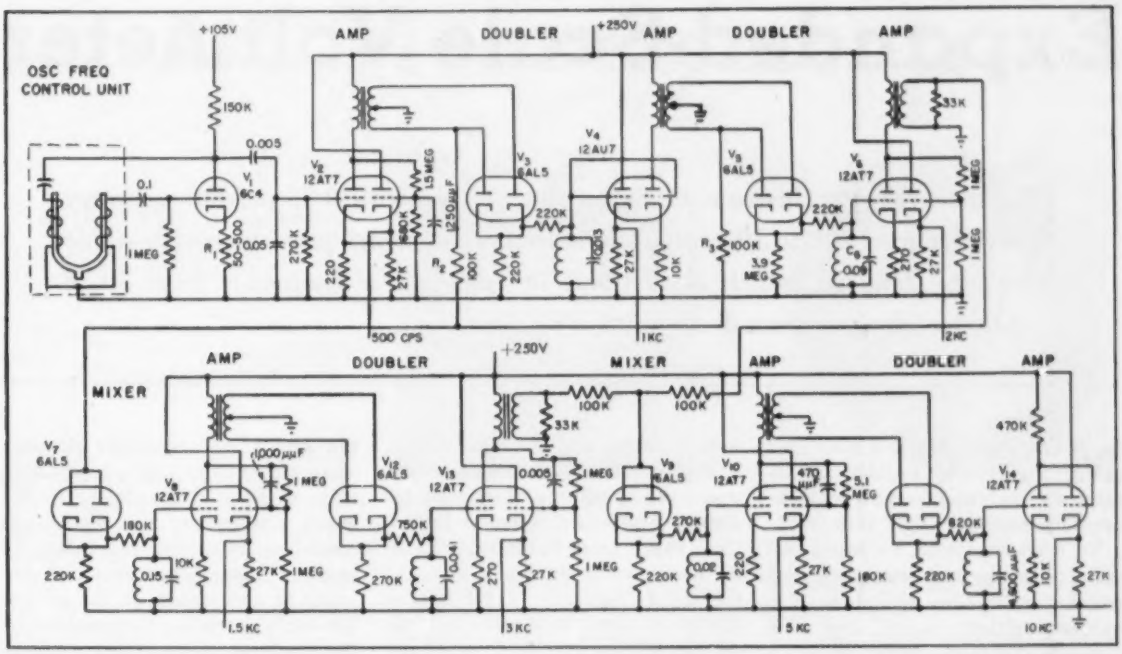


FIG. 2—Schematic of audio-frequency generator employing tuning-fork-controlled master oscillator. Diode frequency multipliers are used to obtain frequency doubling

Alternately, two of the available frequencies could be added and then rectified to provide either their difference or sum and associated harmonics.

Diode Doubler

The second method was used because it required only a single tube, a diode. Two mixing stages are incorporated which furnish output at 1,500 and 5,000 cycles. Each of these stages combines two frequencies whose sum or difference is desired and the resultant voltage is then rectified. If the two voltages are represented by $E_1 \sin \omega_1 t$ and $E_2 \sin \omega_2 t$, the Fourier expansion of the rectified output contains the two terms $k\,E_1\,E_2 \sin\,(\omega_1 + \omega_2)t$ and $k\,E_1\,E_2 \sin\,(\omega_1 - \omega_2)\,t$ where k is a mathematical constant of proportionality.

The rectifier output will contain voltage components whose frequencies are equal to the sum and the difference of the two original frequencies. The particular component desired may then be selected by a suitable tuned circuit similar to that previously described in this article.

The 500-cycle and 1,000-cycle voltages, obtained from V_3 and V_4, respectively, are combined through resistors R_2 and R_3 and applied to the diode mixer V_7. The 1,500-cycle component is selected from the mixer output by a tuned circuit and amplified by V_8, fed through diode doubler, V_{12} to furnish a 3,000-cycle output.

A second diode mixer, V_9, provides a 5,000-cycle output by combining the 3,000-cycle and 2,000-cycle voltages. The 5,000-cycle voltage is then amplified by one half of V_{10} and rectified by the final diode frequency multiplier to provide an output frequency of 10 kilocycles. The number and choice of output frequencies is determined by the particular requirements of the application and not limited to those shown here.

Advantages

Reliability is inherent in this experimental standard-frequency generator because all tubes are operated conservatively and use of capacitors has been held to a minimum. Because there are no multivibrators nor oscillating circuits other than the master oscillator, output is limited to the frequencies designed into this piece of equipment.

Power-supply requirements are simplified because variations in supply voltage affect only the oscillator circuit. An OB2 voltage-regulator tube of the glow-discharge type provides adequate regulation of oscillator plate voltage for practically all purposes. Total power-supply drain is approximately 60 milliamperes.

All output voltages are available simultaneously at 500 cycles, 1, 1.5, 2, 3, 5 and 10 kilocycles. Peak-to-peak amplitude of all outputs is 20 volts. No perceptible drift has been observed at any time during long periods of continuous operation of this equipment.

The author expresses his appreciation to D. Mawhinney who constructed the unit and simplified many of the difficulties prior to the completed design.

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(1) F. E. Terman, "Radio Engineer's Handbook", p 950, McGraw-Hill Book Co., Inc., New York, 1943.
(2) E. Norrman, A Precision Tuning-Fork Frequency Standard, *Proc IRE*, **30**, p 1,715, Nov. 1952.
(3) F. E. Terman, "Radio Engineer's Handbook", p 480, McGraw-Hill Book Co., Inc., New York, 1943.
(4) Seeley, "Electron Tube Circuits", p 486, McGraw-Hill Book Co., Inc., New York, 1950.

Expanded-Scale Voltmeter

SUMMARY — Instrument shows rms voltage with 0.25-percent accuracy over range of 100 to 500 volts. Hot-wire thermal bridge provides highly stable voltage standard, which is relatively independent of frequency from 50 to 2,000 cycles per second

MANY applications in electronic engineering require an indicating instrument that will accurately measure high voltages.

To meet this need, an expanded-scale voltmeter has been developed which permits the indication of a narrow voltage range over the complete indicating-meter scale.

In the laboratory-model instrument, a tapped input transformer permits this voltage range to be placed conveniently, so that in actual use the applied voltage is equal to the sum of the readings of two knobs plus the reading of the meter. In the panel-mounted voltmeters, this adjustable feature is eliminated and the scale is expanded about the nominal voltage.

Accuracies of 0.25 percent over a frequency range of 50 to 2,000 cycles are achieved in the laboratory-model voltmeter and accuracies of 0.5 percent over the same frequency range are achieved in the panel meter. Sensitivities as high as 0.3 inch per volt are obtainable.

Principle of Operation

A thermal bridge is used as the voltage standard in both models of the expanded-scale voltmeters. By exploiting the nonlinear properties of a hot wire, a highly stable voltage standard has been developed. This element is used in a bridge circuit with wire-wound resistors to give a system whose output is shown in Fig. 1. The output voltage goes through a null at an input of E_s. For small deviations from E_s, the output voltage is proportional to $(E_{in} - E_s)$. Since the nonlinearity is produced by heating of the wire, the indication is rms and relatively independent of the frequency.

High-frequency limitations imposed are those of wire-wound resistors and low-frequency limitations result from distortions caused by nonlinearity during a cycle of the input frequency. These impose limits of about 20 to 100,000 cps on the voltage standard. Accuracy of 0.1 percent can be obtained.

The temperature coefficient of the bridge is very small because of the high operating temperature of the wire in the nonlinear element, since a change in ambient produces only a small percentage in the wire's temperature rise. This small coefficient is compensated for by using a temperature-sensitive resistor in one branch of the bridge. The high operating temperature of the nonlinear element also produces rapid response to voltage changes.

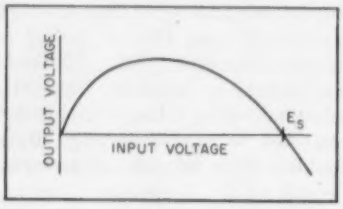

FIG. 1—Characteristic of hot-wire thermal bridge used as voltage standard

Laboratory Model

The circuit of the laboratory model of the expanded-scale voltmeter is shown in Fig. 2. The nonlinear voltage standard is driven from a precision tapped transformer which permits measuring a wide range of input voltages. The taps are arranged in decades with 10-volt steps from 100 to 390 volts on the input, providing exact input ratios to the voltage standard. An accurately center-tapped secondary

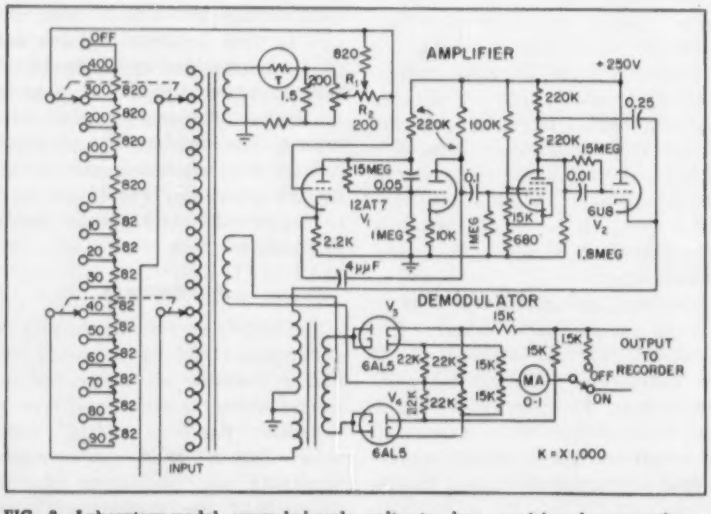

FIG. 2—Laboratory-model expanded-scale voltmeter has provision for operating 1-milliampere external recorder

for A-C Measurements

By HERBERT GALMAN

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Expanded-scale voltmeter is read by adding dial settings to meter reading

Panel-model meter has circuitry in can attached to meter housing

on the transformer permits eliminating two resistors in the bridge to give a half-bridge voltage standard. The transformer has 0.1-percent accuracy from 50 to 5,000 cps.

The transformer-voltage standard combination produces an output proportional to $(N_s/N_p)(E_m - E_s)$ where N_s/N_p is the ratio of the transformer's secondary voltage to its primary. By multiplying this output by N_p/N_s, a voltage proportional to $[E_m - (N_p/N_s)E_s]$ is obtained. Since N_p/N_s was chosen to be decade voltages from 100 to 490 volts in 10-volt steps, a method of accurately subtracting these voltages from the input voltage is obtained. This subtraction is rms.

The amplifier, consisting of V_1 and V_2, multiplies the voltage standard's output by N_s/N_p through changing the feedback resistors with changes in the transformer taps. Negative feedback makes the gain very accurately proportional to the feedback resistors. The feedback reduces the gain by more than 100, giving almost complete freedom from change of gain due to variations in tubes and associated components.

The amplifier's output transformer drives V_3 and V_4— a balanced, full-wave, phase-sensitive demodulator. This demodulator produces an output of one milliampere to drive a panel meter. In addition, terminals permit operation of a 1-milliampere recorder. The high output resistance of 30,000 ohms produces optimum response from the recorder.

Because of the balanced operation and the high output voltage of the demodulator, negligible zero drift is encountered in this stage making a zero adjustment unnecessary.

Potentiometer R_1 adjusts E_s and is set by applying an input of 100 volts to the instrument from an accurate standard and setting the decade knobs to 100. The potentiometer is then adjusted to bring the panel meter to zero. Potentiometer R_2 sets the full-scale reading of the panel meter and is adjusted by applying 110 volts and making the panel meter read 10.

Waveform Correction

The demodulator reads the average value of the voltage applied to it. This results in a waveform error. Since this error is only in the difference output of the voltage standard, the resulting error is usually negligible.

Typical errors are given in Table I, which gives the error in volts. This table shows that no waveform error exists at the 0-volt end of the panel-meter scale. Maximum error occurs at the 10-volt end of the scale. For a given harmonic content, the maximum error in volts is independent of the voltage range used. For normally encountered waveforms, with less than 10-percent distortion, only small errors will result.

To operate the voltmeter the hundreds and tens knobs are turned to bring the meter needle on scale and the setting of the knobs are added to the meter reading. For example, 200 + 30 + 3.7 = 233.7 volts. The meter has a full scale reading of 12 volts, giving a 2-volt overlap and eliminating the necessity of switching back and forth when the voltage is close to the end of the scale.

Panel-Mounting Meter

The panel-model of the expanded-scale voltmeter, Fig. 3, has one range. The network containing the voltage standard and demodulator are packaged in a hermetically sealed can attached directly to the meter itself.

In this version of the voltmeter the thermal bridge is operated at a voltage of 6 or 12 volts. A transformer is used to step down the input voltage to the proper voltage for bridge operation.

Table I—Typical Voltage Errors

Harmonic Content	RMS Voltmeter Reading					
	100	104	108	400	404	408
10% 2nd	0	0	0	0	0	0
10% 3rd	0	0.15	0.30	0	0.15	0.30
10% 4th	0	0	0	0	0	0
10% 5th	0	0.10	0.20	0	0.10	0.20
10% 7th	0	0.06	0.12	0	0.06	0.12

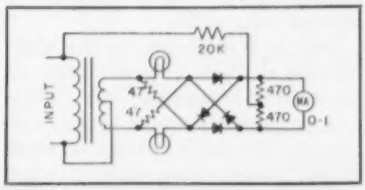

FIG. 3—Panel-type expanded-scale voltmeter for specific voltage ranges

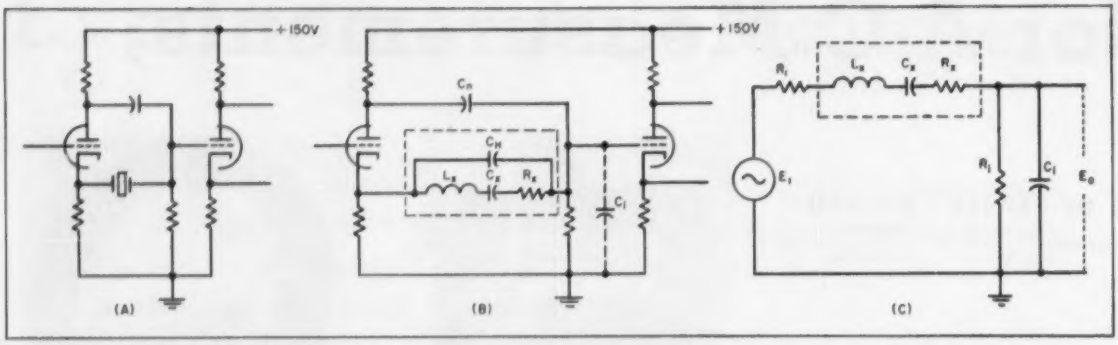

FIG. 1—Crystal filter circuits showing basic staggered element (A), with its equivalent circuit (B) and a further simplification (C)

Staggered Triple

SUMMARY —— Narrow-band filter with extremely sharp skirts is provided by piezoelectric crystals in stagger-tuned system. Circuit functions from 400 kc to 5 mc by suitable choice of crystals

By D. E. HILDRETH

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Santa Barbara, California

RECENT DEVELOPMENTS found in mechanical filters and the more familiar lattice systems seem to cover sharp filter applications quite well. However, the need occasionally arises for a filter outside of the frequency range of the mechanical filters or more simple in terms of component requirements and adjustments than lattice systems. Results with the staggered crystal filter shown here have been promising.

Unit Function

Basically, a staggered element in this system contains a phase inverter, to facilitate neutralization of crystal holder capacitance, a crystal and an isolation stage which may be a cathode follower or an amplifier. Maximum energy is transferred to the isolation stage at the series-resonant mode of the crystal. Circuit Q can be altered by the addition of resistance in series with the crystal-neutralizing circuit and the input of the isolation stage of this system.

Design criteria for the use of staggered elements is well covered in the literature.[1] Design criteria usually given is to enable the design of a system with maximal flatness. Higher Q's than those dictated by design criteria can be used where peak-to-valley ratios on the order of 3 to 6 db can be tolerated. The allowance of a peak-to-valley ratio is usually more than compensated for in terms of a superior skirt-shape factor.

A basic element is shown in Fig. 1A and its equivalent circuit is shown in Fig. 1B. It is further simplified in Fig. 1C.

If Fig. 1C is used to evaluate an indication of stage gain at resonance and R_i is made much larger than X_{ci}, the approximate equation for stage gain is the following

$$\text{Gain} = \frac{E_o}{E_i} = \frac{IX_{ci}}{E_i} = \frac{X_{ci}}{R_i + R_s}$$

A typical apparent voltage gain for a crystal circuit at 400 kc assuming C_i to be 5 $\mu\mu$f and total R to be 5,000 ohms would be 80,000/5,000 = 16.

System Results

The circuit shown in Fig. 2 is the prototype which was built to be used with 400-kc crystals. The curve shown in Fig. 3 indicates frequency response which was present with a voltage gain of 20.

Figure 4 indicates results when crystals at 1.599, 1.600 and 1.601 mc were used. Inherently, this system is most practical where overall system Q's are on the order of 2,000 to 20,000. Where lower system Q's are required, staggered systems employing Q multipliers or normal

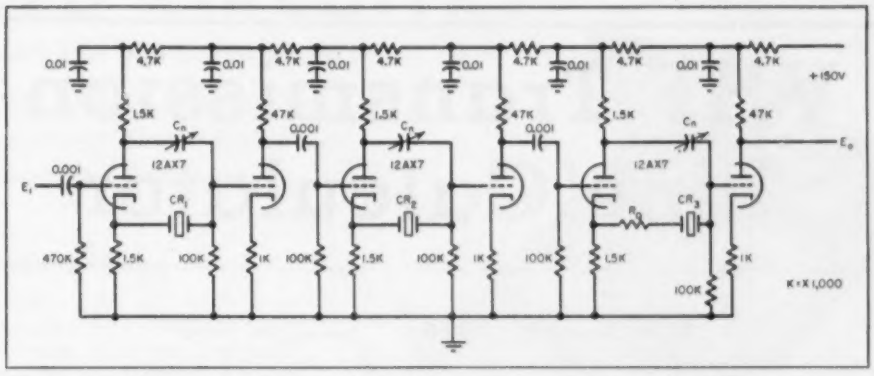


FIG. 2—Circuit diagram of prototype model of staggered triple crystal filter using 400-kc crystals

Crystal Filter

resonant circuits may be used to advantage.

Since resistance (R_e in Fig. 2) must be added in series with a series resonant circuit to reduce Q, the circuits shown would result in signal attenuation rather than gain if crystals were to be used for low-Q elements. This may easily be determined by referring to the gain equation where the Q-reducing resistance would appear in the denominator of this expression.

Where skirt-rejection requirements are not too severe, a single staggered pair may be used or a single crystal circuit where a sharp peak is desired.

Applications of this type of filter system seem to be large. It may readily be adaptable in the elimination of the double-heterodyne process in some high-frequency receiver applications where a high degree of both image rejection and selectivity are required. The size of such equipment could immediately be reduced and less shielding would be required to reduce the multiple beats present when more than one local oscillator is used in a receiver system.

Reference

(1) H. Wallman, Stagger-Tuned Amplifier Design, p 682, "Electronics Manual for Radio Engineers," Zeluff and Markus, McGraw-Hill Book Co., New York, 1949.

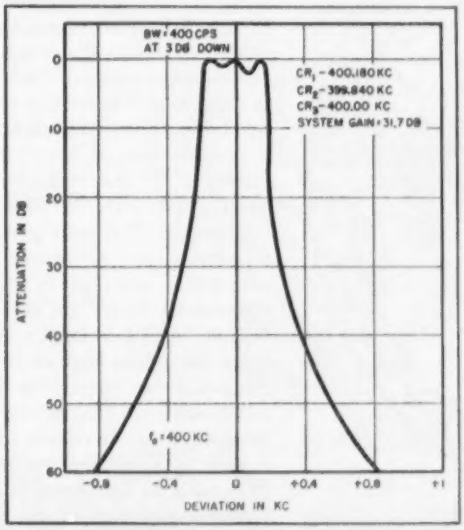


FIG. 3—Frequency response of filter circuit using 400-kc crystals with a voltage gain of 20

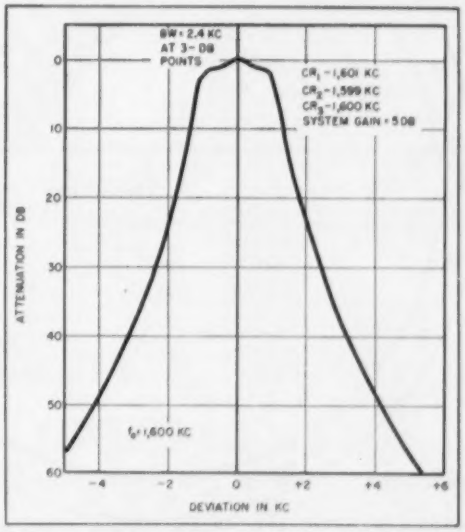


FIG. 4—Curve shows frequency response with a center frequency of 1,600 kc

VHF Transmission Line Calculator

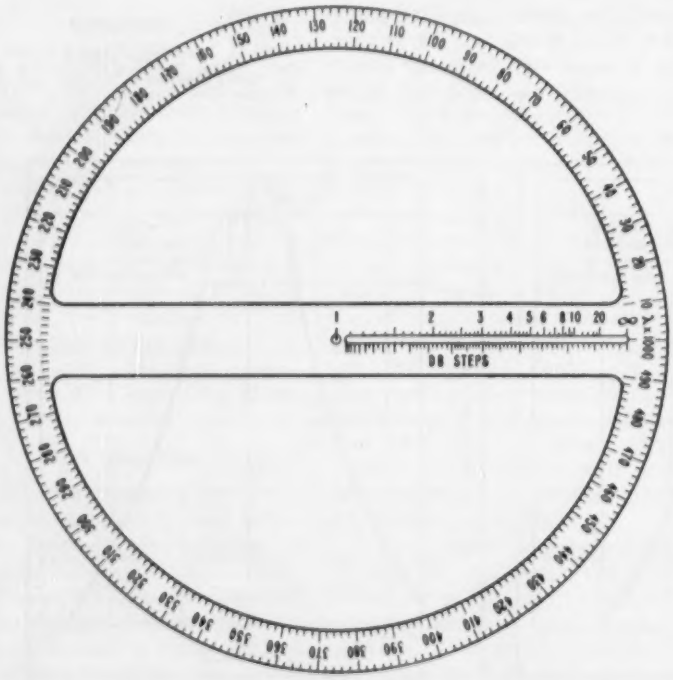
By A. E. SANDERSON *Aircraft Radio Corporation, Boonton, New Jersey*

SUMMARY — Phase shift and attenuation introduced by transmission line connecting unknown impedance and measuring equipment can be quickly corrected by use of simplified calculator dial together with Smith or Z-θ chart. Dial is also useful in design of filters, antennas and matching networks

CORRECTION of vhf impedance measurements for phase shift and attenuation introduced by the transmisson line connecting an unknown impedance with measuring apparatus can be made with the calculator shown here.

It is used in conjunction with either a Smith chart or Z-θ chart. With this device corrected measurements may be plotted directly on the Smith chart without the necessity of reading values from a separate calculator and transcribing them. Scales not necessary for transmission line corrections are omitted for simplicity on the chart below.

An impedance curve plotted on these charts is valuable in the design of vhf filters, matching networks and antennas. Such a curve will tell not only how good the network may be in terms of vswr, but with proper interpretation, will tell exactly what steps should be taken to perfect the design of the network.



Calculator Design

The transmission line calculator consists of a clear plastic disk about 8 inches in diameter with printed scales. Two D-shaped sections and a radial slot are cut out of the disk to allow marks to be made directly on the graph paper as the measurements are taken. A small hole is located at the center for a thumbtack pivot.

A scale around the outer perimeter of the calculator is marked off in units of 1/1,000 wavelength. The scale goes from 0 to 500, since 1 revolution of the calculator corresponds to the phase-shift correction for a section of line $\frac{1}{4}\lambda$ in length. A scale along the upper edge of the radial slot from the center to the outer edge of the calculator is marked off in vswr from 1 at the center to ∞ at the outer edge. This scale is nonlinear, but may easily be calculated from the re-

(Continued on page 170)

ETCHED CIRCUITRY

AND RELATED ASSEMBLIES

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Developed and produced for right angle application. The right angle board accommodates all of the CINCH socket sizes, and can be bonded with epoxy resin or snapped in and retained by newly developed CINCH hardware. All units meet or exceed Military Specifications.

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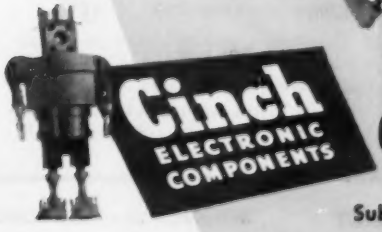

GRAPHIK CIRCUITS Division of Cinch Manufacturing Corporation

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CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

VHF Transmission Line Calculator

(Continued from page 168)

lation vswr = $(1 + \Gamma)/(1 - \Gamma)$ where Γ is a linear function, being 0 at the center and 1 at the outer edge. This scale allows impedance points to be interpreted directly in terms of vswr.

A third scale extends along the lower side of the radial slot from the center to the outer edge of the calculator. This scale is marked off in db steps, starting from the outer edge as reference. Each db step represents the radial movement of a point by a given percentage of its distance from the center. Since this motion can be either toward or away from the center, no numbers appear on the scale. Lines marking 1-db steps are longer than the intermediate lines. This scale allows corrections to be made for the effect of line attenuation.

To determine proper line corrections as a function of frequency for the length of line used between the measuring equipment and an unknown impedance, the line is first terminated in a known or calibrating impedance. This may conveniently be a short circuit. The input impedance of the line is then measured at one frequency and the point is plotted on the Smith chart. The calculator is placed over the Smith chart and rotated until the slot is aligned with the point. Assuming a short-circuit termination, the phase correction for the line is read on the outer scale of the calculator at zero ohms on the Smith chart. The attenuation correction is the number of db steps between the measured input impedance point and the outer end of the scale.

This process is repeated for each frequency at which measurements are to be made and the phase and attenuation corrections recorded. The line input impedance can then be transformed to corresponding terminating impedances and plotted directly on the Smith chart.

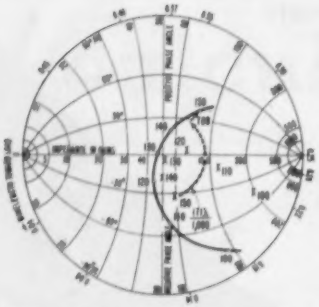

FIG. 1—Solution of transmission line problem. Input impedance of transmission line is indicated by crosses and impedance of antenna by circles

To do this, the short-circuit is replaced by the unknown impedance and the input impedance of the line is measured at one of the chosen frequencies. The slot of the calculator is then positioned over the point representing this measured impedance. Moving outward along the slot from this point by the tabulated db step correction gives the vswr of the unknown terminating impedance. The calculator is then rotated counterclockwise by the tabulated phase correction and the chart is marked through the slot opposite the vswr previously established. The impedance represented by this point is the terminating impedance.

With lines that are several wavelengths long, some precautions should be observed. Frequencies of measurement must be accurately determined, preferably with a crystal calibrator, because a small frequency error will result in a large error in the phase-shift correction.

Attenuation correction may become large and should therefore be determined quite accurately. For best accuracy, the calibrating impedance should have a vswr fairly close to that of the unknown impedance since the attenuation of the line is a function of vswr and will be greater for large vswr. If such a calibrating impedance is used, the line corrections must be determined by a method analogous to that described above for a short-circuit termination.

Table I—Line Corrections for 133-mc Antenna

Frequency in Mc	Phase Correction $\frac{\lambda}{1{,}000}$	Attenuation Correction in Db Steps
100	455	0.7
110	398	0.7
120	341	0.7
130	285	0.7
140	228	0.7
150	171	0.7

Example

As an example, consider the determination of the input impedance and resonant frequency as seen at the terminals of an experimental antenna unit mounted on a finite ground plane. The desired resonant frequency is 133 mc. The line used to feed this antenna has a characteristic impedance of 50 ohms.

Figure 1 illustrates measured data on such an antenna, plotted with the calculator. The antenna was replaced by a short-circuit and input impedance of the shorted line was measured at 100, 110, 120, 130, 140 and 150 mc. A table of line corrections was then made up (see Table I). The antenna was put back on the line, the new input impedances were measured, corrections applied and a corresponding series of five points were obtained. A smooth curve connecting these points intersects the axis of pure resistance at 46 ohms. The frequency at which this occurs is 129 mc. When the antenna was shortened to become a pure resistance at 133 mc, the vswr was 1.08.

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P. H. Smith, An Improved Transmission Line Calculator, ELECTRONICS, p 130, Jan. 1944.

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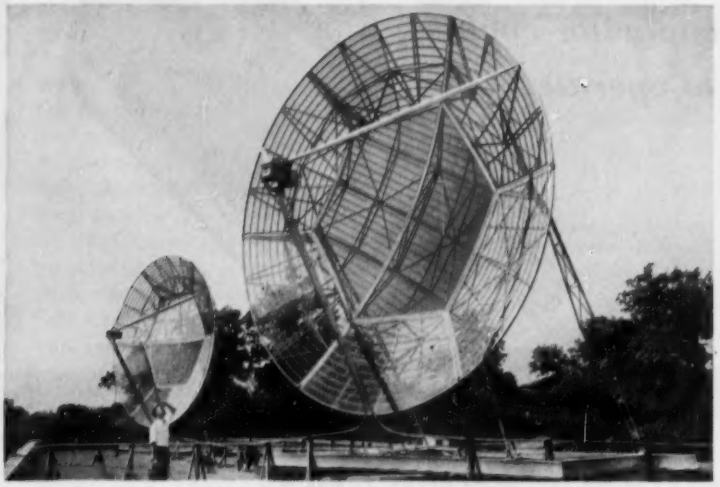
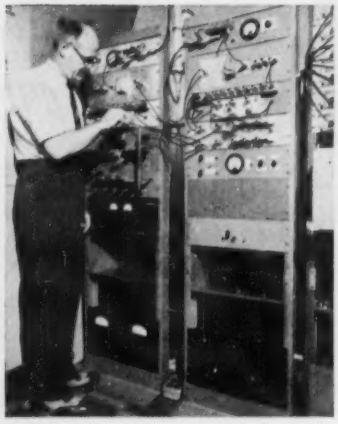
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Over-Horizon Radio To Link Islands



Pair of 28-foot paraboloidal diversity antennas at Nutley, N. J.



Technician adjusts frequency division multiplex f-m receiver at Nutley terminal of tropospheric 91-mile 900-mc circuit to Southampton, N. Y.

PROPAGATION over distances in the order of 200 miles using uhf has recently proved feasible when appreciable transmitting power and diversity reception are suitably employed.

Tropospheric beyond-horizon circuits are to be installed between Florida and Cuba in a joint endeavor of American Telephone and Telegraph Co. and International Telephone and Telegraph Corp.

In addition, Radio Corp. of Porto Rico, IT&T subsidiary has recently filed application with FCC for the development of a radio link between San Juan, Puerto Rico and Ciudad Trujillo, Dominican Republic. The new link will be necessary to meet increasing traffic demands. Propagation tests will probably start in late 1955.

Experimental work in progress at Federal Telecommunication Labs (IT&T subsidiary) includes a 91-mile, 900-mc multiplex circuit between Nutley, N. J. and Southampton, L. I., N. Y. Loss over the path exceeds by some 30 db that predicted or encountered elsewhere. Some of the loss may be seasonal in character and some may result from the proximity of a ridge formed by the Palisades along the Hudson River. There appears to remain an additional loss factor that is suspected to arise from the overland nature of the path, perhaps from the over-city portion.

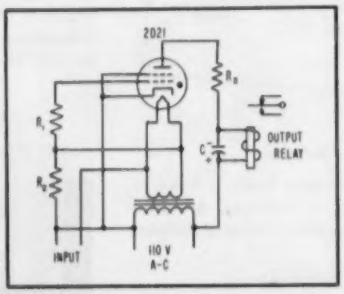
Sensitive Thyratron Relay Operates On Microampere

By JOHN N. HARRIS

Staff Member
Lincoln Laboratory
Massachusetts Institute of Technology
Lexington, Mass.

OFTEN there is need for a very sensitive relay that will operate from currents as low as a microampere. The circuit shown here has been successfully used in conjunction with a mercury thermoregulator for controlling temperature. It is suitable for many other applications.

When the input is open, the grid is returned through R_1 and R_2 to the cathode and the tube is ignited during the positive portion of the cycle. When the input circuit is closed, the filament voltage is in series with the grid return (since $R_2 >>$ resistance of the filament winding) and of such a phase as to prevent the tube from igniting.



Circuit of the sensitive thyratron relay

Resistance R_3 is chosen so that the rated current (usually 1 to 10 ma) passes through the relay. A resistance of 10,000 to 30,000 ohms has been satisfactory in most cases. The capacitance C is across the coil to prevent chattering and may be about 12 μf. Resistors R_1 and R_2 are chosen to satisfy the input impedance and current limitations. When it is desired to have very low current in the input circuit, values

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- AC, DC Switches, Fuses, and Pilot Lights on Front Panel.
- Color Grey Hammertone.
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Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 8	0-150	Each supply	19"	10½"	13"	$330
KR 5	100-200	has two	19"	10½"	13"	$240
KR 6	195-325	10 Amp.	19"	10½"	13"	$240
KR 7	295-450	outputs.	19"	10½"	13"	$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 11	0-150	Each supply	19"	7"	11"	$180
KR 1	100-200	has one	19"	7"	7½"	$ 90
KR 2	195-325	3 Amp	19"	7"	7½"	$ 90
KR 9	295-450	output	19"	7"	7½"	$ 97

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 1-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR1-C) and Add $10.00 to the Price.
To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-1MC) and Add $40.00 to the Price.
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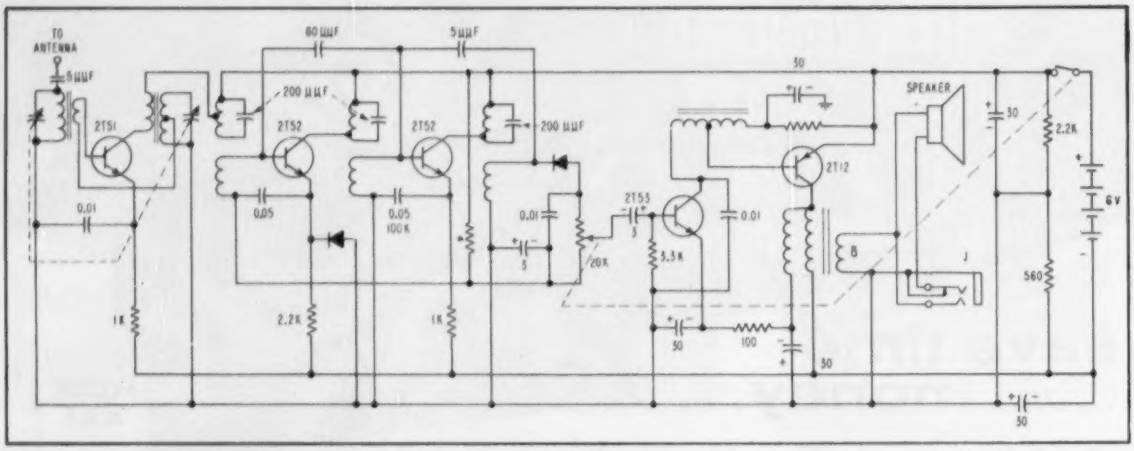
of $R_1 = 1$ megohm and $R_2 = 4$ megohms have been used. However, for many applications $R_1 = 250{,}000$ and $R_2 = 100{,}000$ have been found satisfactory.

For load requirements exceeding the rating of the output relay, a second power relay may be operated from it.

The research in this development was supported jointly by the Army, Navy, and Air Force under contract with the Massachusetts Institute of Technology, at Cambridge, Massachusetts.

Japanese Transistor Broadcast Receiver

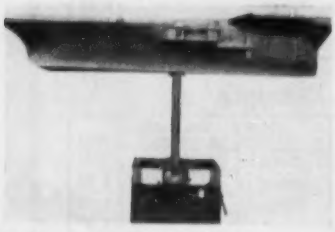


Circuit diagram of the Sony TR-55 transistor superheterodyne broadcast receiver

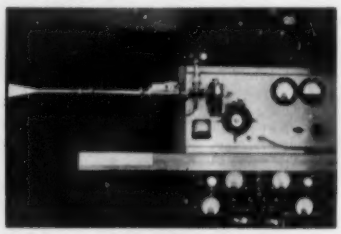
FIVE TRANSISTORS are used in a superheterodyne radio broadcast receiver built by Tokyo Tsushin Kogyo, Ltd. of Japan, licensees of Western Electric Co. Printed circuit wiring is employed. The output jack permits use of an earpiece instead of the self-contained 2½-inch loudspeaker. Four penlight cells furnish 6 volts on which the receiver operates for about 50 hours.

Power output of 10 milliwatts is possible with 10 percent distortion. Field strength required is between 1 and 2 millivolts per meter. The receiver tunes from 535 to 1,605 kc. Intermediate frequency is 455 kc. Selectivity is approximately 15 db at 10 kc off resonance. Photographs of the set were shown on page 12 of the October ELECTRONICS.

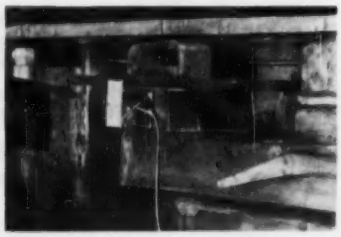
Antenna Arrays Insure Flat-Top Communications



Scale model on rotating pillar



Microwave generator and horn

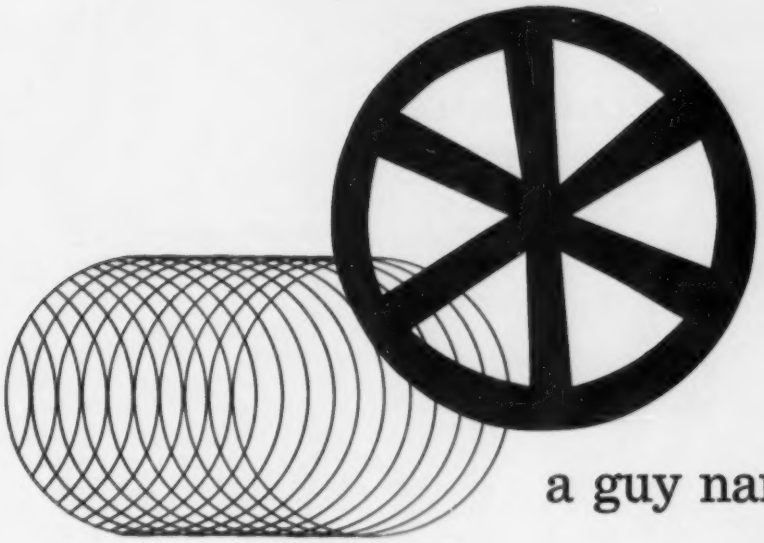


Detail of model receiving antenna

MODERN aircraft carriers like the *U. S. S. Forrestal* have a double problem installing effective antennas. The antennas must furnish reliable service over 360 degrees of direction. In addition, they must be effective over reasonable degrees of azimuth. But the antenna structures must not constitute a flight hazard and must be substantially unaffected by other structures.

The *Forrestal's* uhf radio gear, used to communicate with jet aircraft, is said to have an effective range of 1.5 times that of previous equipment. Eight diversity antennas are located on the gun tubs and corners of the flight deck. By virtue of their positions, the antennas are free from the interfering effects of other antennas, ship superstructure and reflections from the sea.

Even with antennas at half their former height the new uhf system



a guy named Og

Once your name was Og. You tired of shouldering mastodon steaks...of dragging your mate by her hair. You invented the wheel.

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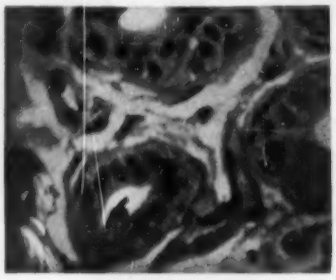

AN ELECTRONIC microscope designed by CBS Laboratories allows researchers in medicine and industry to view microscopic objects in color. Components of the system include a standard laboratory microscope, color camera, camera control console, color monitors and projectors.

Resultant images from the system are brighter than images using conventional optical methods. In addition, much less light is required at the specimen. Large bright color images using strictly optical microprojectors require such large amounts of light that many live specimens and some fixed slides are destroyed. Consequently, many specimens which up to this time have escaped practical enlargement can now be observed.

In this system, a color camera is mounted on a laboratory microscope. The optics are adjusted to focus the real field through the color drum segments onto the face of the single image-orthicon pickup tube.

The field-sequential system uses a 24 cps color-frame repetition rate. Horizontal scanning frequency is 29,160 cps and the vertical frequency is 144 cps interlaced 2 to 1. Aperture correction and crispening circuits are used.

The image from the compound microscope normally viewed by the eye is, in the color microscope, formed at the photocathode of the image orthicon. This image, with a diagonal of 1.6 in, is amplified electronically in brightness and then magnified in size to a diagonal of approximately 11.5 in. on a small monitor, 18.5 in. on a larger monitor and 83 in. on a large-screen projector. This results in image size magnification of 7, 12 and 52 respectively. Using a 2-mm objective and a 10× ocular, the overall magnification can be 46,800.

provides greater communications range than equipment used in World War II.

Characteristics of the antenna system were tested in advance by Federal Telecommunication Labs using a scale model of the carrier equipped with a scaled receiving antenna. The rotating model was illuminated by a microwave horn and recordings made of signal strength versus orientation.

Digital Voltage Divider Using Four Resistors

By L. J. KAMM

Chief Electrical Engineer
Schatzki Engineering Co.
Springfield Gardens
Long Island, N. Y.

DIGITAL voltage dividers are potentiometers consisting of a set of fixed resistors that are switched by a keyboard or other means to effect a voltage division. The simplest is the series type shown in Fig. 1A. When two or more decimal digits are used to set up a voltage division the number of resistors becomes large and since precision resistors must be used, the total cost is high. A parallel type of divider has been developed in which only four resistors are required per decimal digit regardless of the number of digits. Fig. 1B shows the basic circuit.

The output voltage is

$$v = \frac{G_2}{G_1 + G_2} V$$

where the resistors are expressed as conductances.

The value of v can be varied by transferring resistors from group G_1 to group G_2. Proper choice of values for g_1, g_2, make possible a large number of different values of v by different groupings of a small number of resistors. For example for a one digit divider, let $g_1 = 1$ mho, $g_2 = 2$ mho, $g_3 = 3$ mho and $g_4 = 4$ mho.

Then $G_1 + G_2 = 10$ mhos and the combinations that can be made are

Table I—Digital Combinations of G_1 and G_2 Using Four Resistors

$v/V = G_2/(G_1 + G_2)$	G_1	Value in mhos	G_2	Value in mhos
0	$g_1 + g_2 + g_3 + g_4$	10	0	0
0.1	$g_2 + g_3 + g_4$	9	g_1	1
0.2	$g_1 + g_3 + g_4$	8	g_2	2
0.3	$g_1 + g_2 + g_4$	7	g_3	3
0.4	$g_1 + g_2 + g_3$	6	g_4	4
0.5	$g_3 + g_4$	5	$g_1 + g_4$	5
0.6	$g_1 + g_4$	4	$g_2 + g_4$	6
0.7	$g_1 + g_2$	3	$g_3 + g_4$	7
0.8	g_2	2	$g_1 + g_3 + g_4$	8
0.9	g_1	1	$g_2 + g_3 + g_4$	9
1.0	0	0	$g_1 + g_2 + g_3 + g_4$	10

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They meet or exceed requirements for all types of military and industrial electronic apparatus and instruments. They are "extra-protected" by a special Sprague-developed plastic embedding material that performs beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

Permaseal winding forms, resistance wire and embedding material are matched and integrated to assure long term stability at rated wattage over the operating temperature range.

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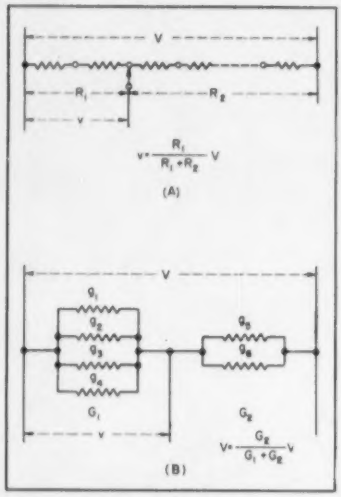


FIG. 1—Simple series voltage divider (A) requires a large number of precision resistors. Parallel type (B) can form a large number of digital values by varying combinations in G_1 and G_2

given in Table I.

Similarly for a two-digit divider, 8 resistors are used with values as follows

$g_1 = 10$	$g_5 = 1$
$g_2 = 20$	$g_6 = 2$
$g_3 = 30$	$g_7 = 3$
$g_4 = 30$	$g_8 = 4$

Resistors g_1 to g_4 are controlled by the hundredths digit switching while resistors g_5 to g_8 are controlled by the tenths digit switching.

For example, to obtain a value $v_1/V = 0.68$ let $G_1 = g_1 + g_2 + g_6$ or $10 + 20 + 2 = 32$ and let $G_2 = g_8 + g_4 + g_5 + g_7 + g_8$ or $30 + 30 + 1 + 3 + 4 = 68$. Then $G_1 + G_2 = 32 + 68 = 100$ and $G_2/(G_1 + G_2) = 68/100$.

With the proper choice of g values,

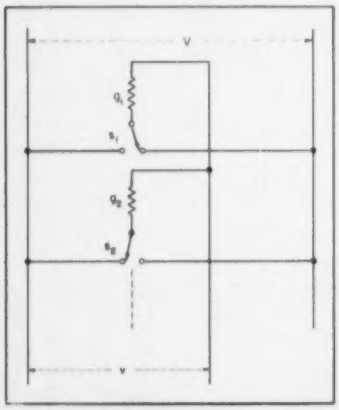
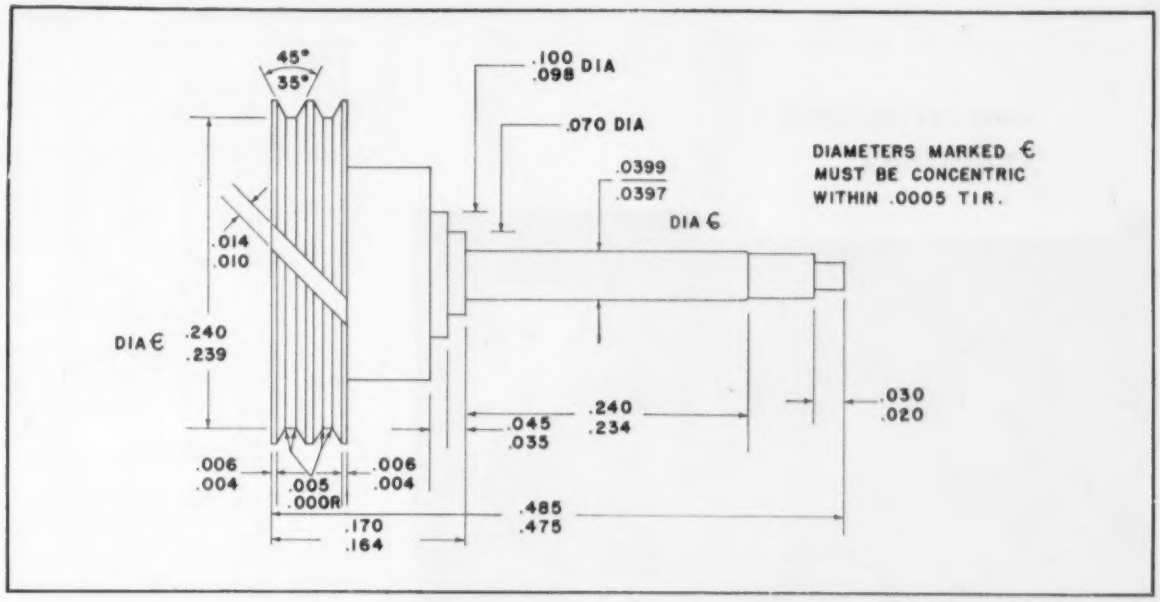


FIG. 2—Single-pole double - throw switching system for transferring resistors between groups G_1 and G_2



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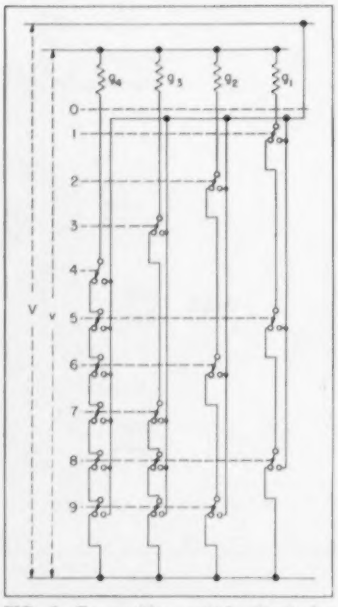

FIG. 3—Ten-position switch circuit for setting up digital voltage values with four resistors

switching for each digit is independent of the switching for the other.

For a three digit divider, 12 resistors are used with values as follows

$g_1 = 100$	$g_5 = 10$	$g_9 = 1$
$g_2 = 200$	$g_6 = 20$	$g_{10} = 2$
$g_3 = 300$	$g_7 = 30$	$g_{11} = 3$
$g_4 = 300$	$g_8 = 30$	$g_{12} = 4$

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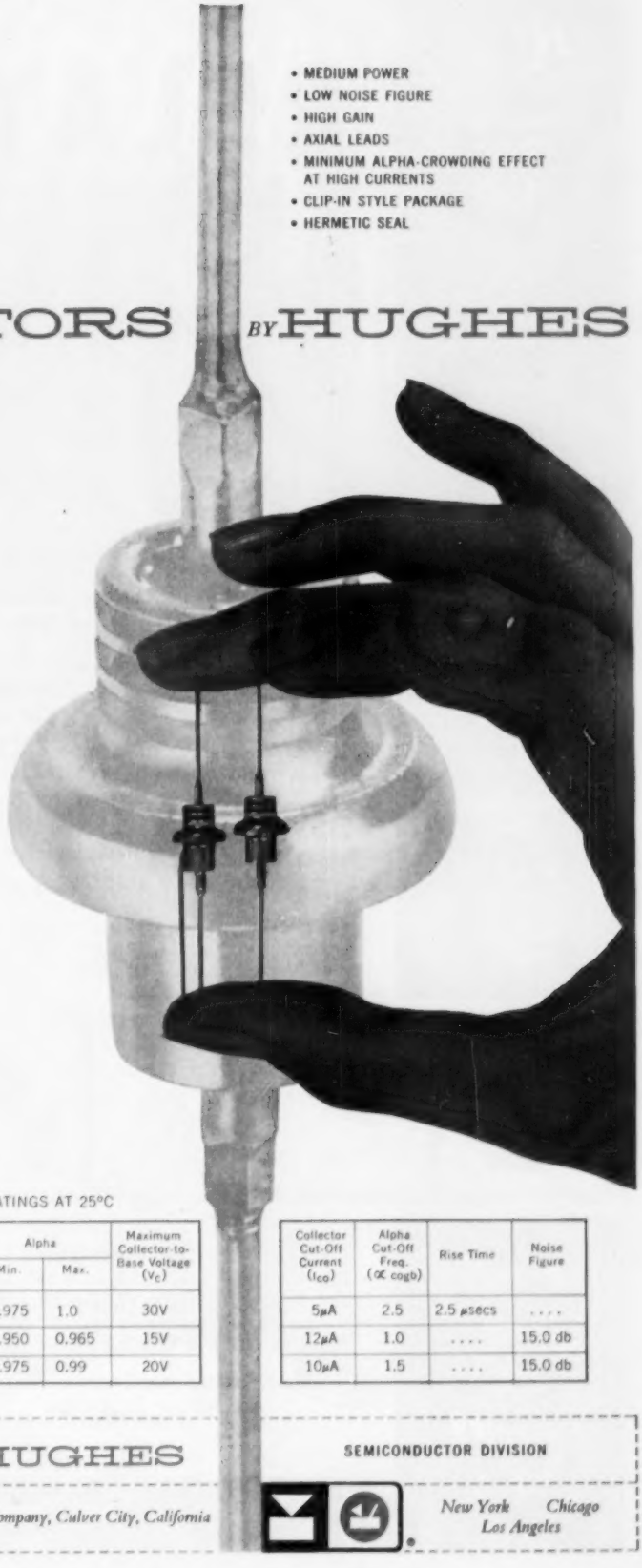

ACTUAL SIZE (photo, transistors in hand).

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HA5003	0.975	0.99	20V

Collector Cut-Off Current (I_{CO})	Alpha Cut-Off Freq. (α cogb)	Rise Time	Noise Figure
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12μA	1.0	....	15.0 db
10μA	1.5	....	15.0 db

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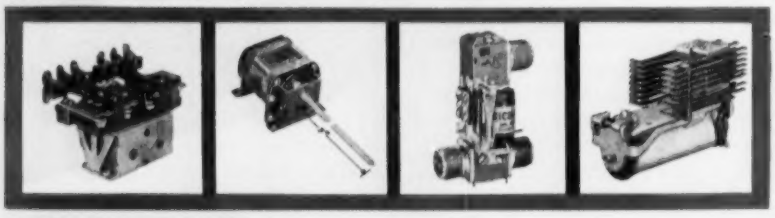

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sistors from group G_1 to group G_2 is to connect one side of each resistor permanently to the output wire and connect the other side to one or the other of the end wires by a single-pole double-throw switch as in Fig. 2.

For manual setting by rotary switch, each resistor is switched by a 10-position switch with certain positions connected to one side of the line and the other positions connected to the other side. For manual setting by keyboard, each key must have 1, 2, 3 or 4 transfer contacts and each resistor wired as shown in Fig. 3 for the single digit case.

Other values of g may be chosen that are equally useful. Also, analgous circuits may be developed for binary and other number systems. This circuit has been used in digital servomechanisms using both 2 digits and 3 digits and has worked satisfactorily.

Zener-Voltage Breakdown Uses In Silicon Diodes

By CARL N. WULFSBERG
Air Force Cambridge Research Center Cambridge, Mass.

GENERAL CHARACTERISTICS of the silicon junction diode shown in Fig. 1 indicate that it differs markedly from the point-contact germanium type in two ways.

Back resistances may exceed 10,000 megohms at moderate back voltages, and a sharp breakdown in back resistance occurs at a particular back voltage, the so-called Zener voltage. A third important difference is the ability of the silicon diode to operate at high temperatures without serious degradation

FIG. 1—Characteristics of silicon junction diodes

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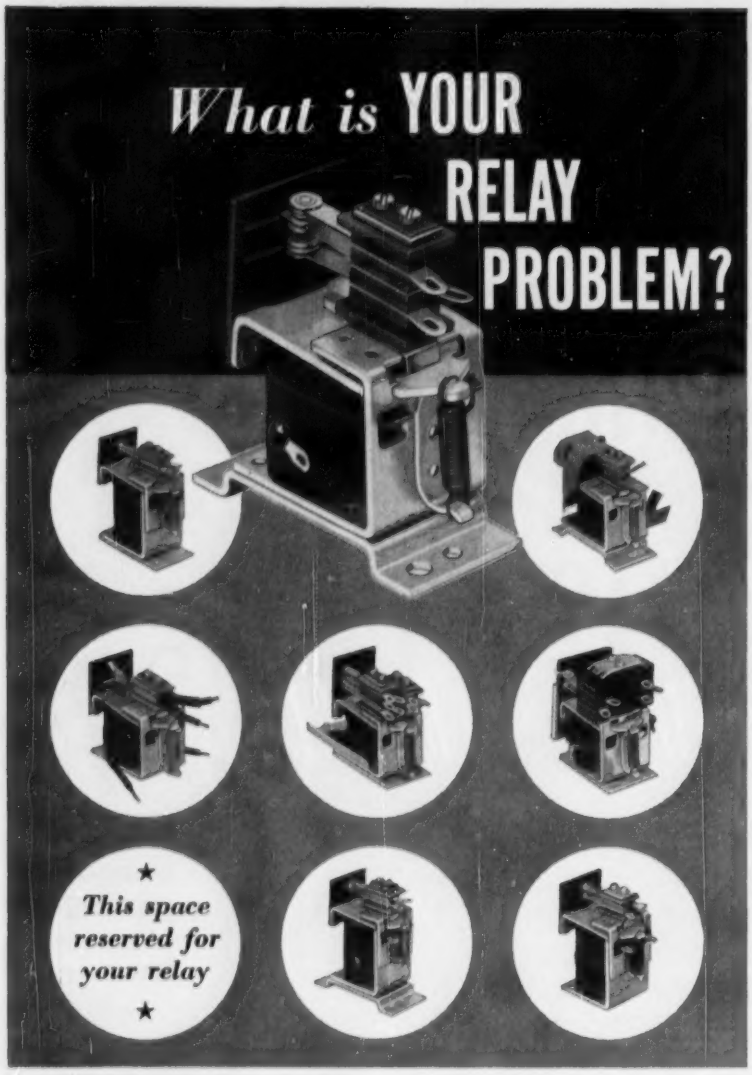

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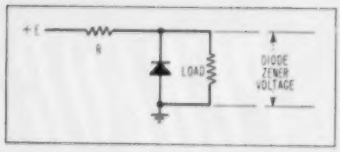


FIG. 2—Direct-current voltage regulator

of its characteristics.

Although back resistance decreases rapidly with increasing temperature, values in excess of a megohm may be expected at 150 C. Forward resistance also decreases, but more slowly, while the Zener voltage normally increases slowly with temperature. Being junction devices, the diodes may have rather

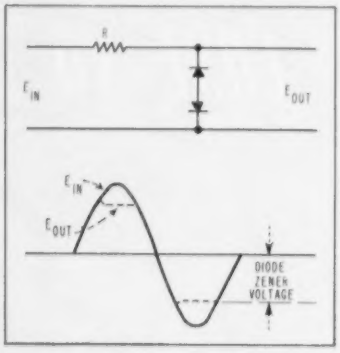
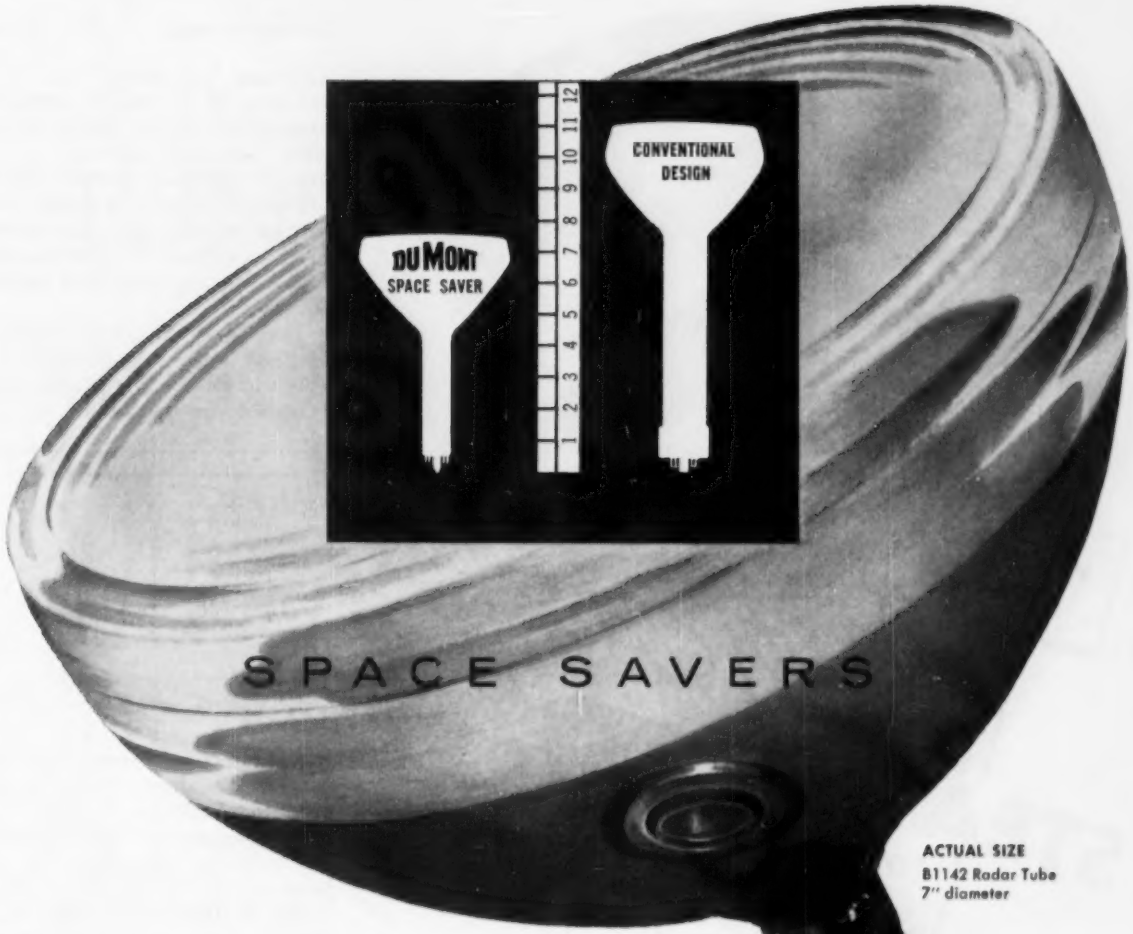


FIG. 3—Alternating-current peak voltage regulator

high shunt capacitances. From one manufacturer's data, very low Zener voltage diodes have capacitances in the order of 50 $\mu\mu f$; the capacitance decreases with increasing Zener voltage and drops to 2 or 3 $\mu\mu f$ for diodes with high Zener voltages.

Numerous applications of silicon diodes in switching circuits suggest themselves, especially where high back resistances are desirable, such as diode gates and matrix switches. Matched pairs and quads are available, which should provide more stable operation than the comparable germanium types in discriminator and modulator circuits, especially under the condition of widely varying temperature. Silicon diodes are efficient rectifiers, with rectification ratios at one volt of 10^6 or higher. High-power types recently made available will undoubtedly find wide application as power rectifiers and in magnetic amplifiers.

Silicon diodes are suited for use in diode-capacitor memory devices;



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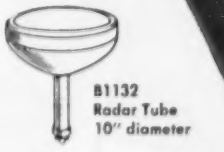

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B1125
Radar Tube
5" diameter

B1144 Radar Tube
5" diameter

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B1144	5"	7"	mag.	mag.	⅞"	16 kv	70°
B1142	7"	8½"	mag.	mag.	⅞"	8 kv	70°
B1132	10"	12½"	elect.	mag.	1-7/16"	10 kv	90°

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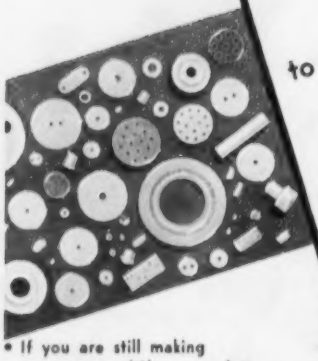

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since the back current may be in the order of 10^{-10} ampere, relatively long storage times should be possible. Low back resistance of the diode at the Zener voltage may be utilized in a number of applications, such as limiting or clipping circuits in which no bias voltage is required and in devices protecting against voltage surges.

Since Zener voltage for a particular diode is constant over wide variations in reverse current, the diode is suited for use in d-c voltage-

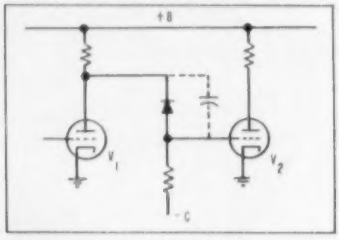

FIG. 4—Diode used as d-c coupling device

regulating or reference circuits, such as that shown in Fig. 2. Resistor R should be so chosen that the reverse current in the diode does not exceed a value given by the ratio of the maximum power dissipation of the diode to the Zener voltage.

Silicon diodes have several advantages over gas tubes as voltage regulators. Since any Zener voltage in the range of three volts to several hundred volts may be specified, the diode is a highly flexible device in this application.

No special provision need be made to insure a minimum starting potential, since this and the working potential are virtually the same in the silicon diode. A further advantage is that the diode may be shunted with a large filter capacitor without danger of oscillation.

A simple a-c peak voltage regulator may be constructed by connecting two silicon diodes back to back, as shown in Fig. 3. The peak output voltage is limited to the Zener voltage of the diodes, which may lie anywhere in the range from three to several hundred volts. This circuit could also be used as an effective speech clipper.

Figure 4 shows a diode used as a coupling device between the plate of one stage of an amplifier and the

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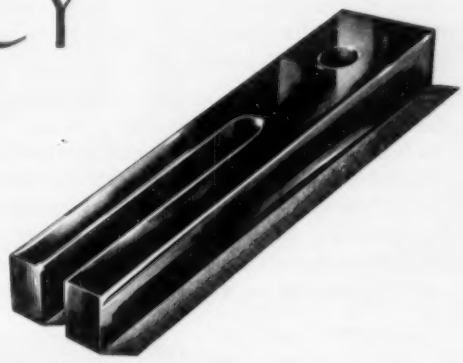

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grid of a following stage. While a resistor may be used in place of the diode to achieve the necessary change in level, there is a signal loss owing to the voltage-divider action of the resistors. By using a diode, the full signal amplitude is retained, the d-c level being reduced by a factor equal to the Zener voltage of the diode.

Good transient response is possible with a proper shunt capacitor. A 1-mc square wave with 0.1-μsec

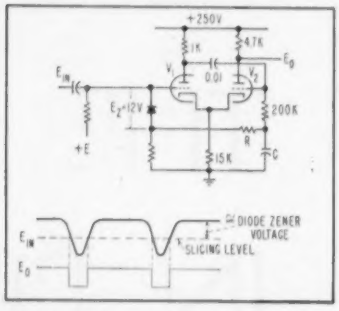

FIG. 5—Silicon diode slicing circuit

rise and fall times was generated at the plate of V_1 of Fig. 4 and, with the diode properly shunted, virtually no change in amplitude or waveform was observed at the grid of V_2. The d-c level, however, was reduced by 60 volts, the Zener voltage of the particular diode used.

Figure 5 shows a fast slicing circuit; V_1 conducts until its grid potential falls below the slicing level, when the current is suddenly transfered to V_2, as indicated by the waveforms. Normally, the grid of V_2 is returned to a fixed direct voltage, which makes the slicing level dependent on the d-c level of the incoming signal.

By including a silicon diode as shown, with a suitable R-C smoothing network, the difference in the d-c levels of the two grids is fixed by the Zener voltage of the diode. With output amplitude dependent on the d-c level of the input signal, there is virtually no change in the slicing operation of the circuit with input levels ranging from 75 to 175 volts.

Silicon diodes facilitate design of a simple and accurate method of converting a binary number stored in a shift register into an analog direct voltage. The accuracy required of such a device is 1 part in

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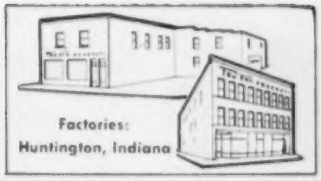

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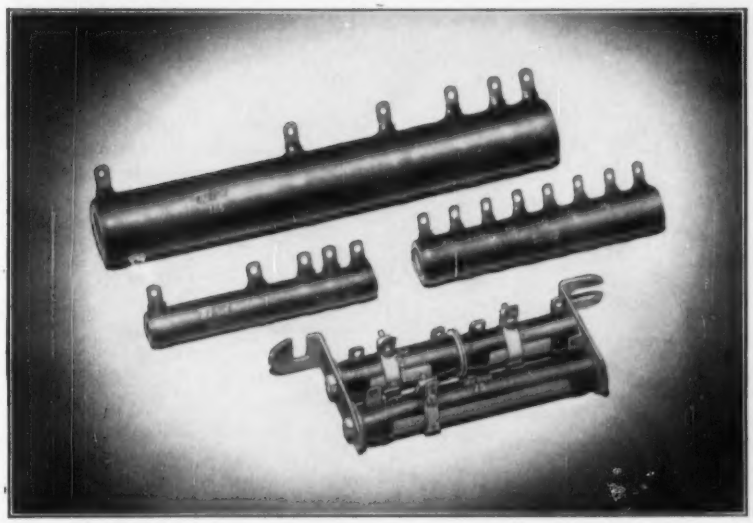

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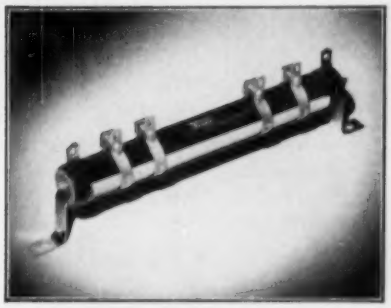

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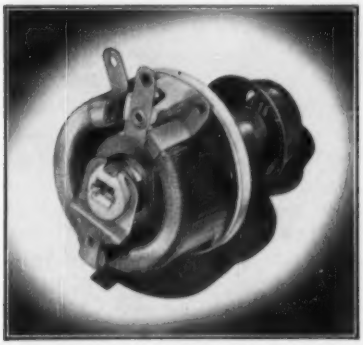

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2^n, where n is the number of binary digits. If n is greater than 4 or 5, it is usually necessary to provide the flip-flops in the register with buffer stages, which may work into a ladder-adding network or drive relays that control suitably weighted resistors.

The method shown in Fig. 6 requires no additional stages, and is relatively independent of tube characteristics and supply voltages. The shift register flip-flops are comprised of pentode pairs, with the

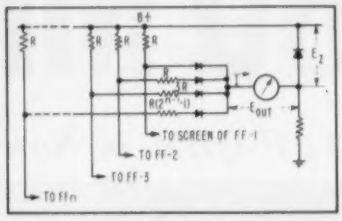


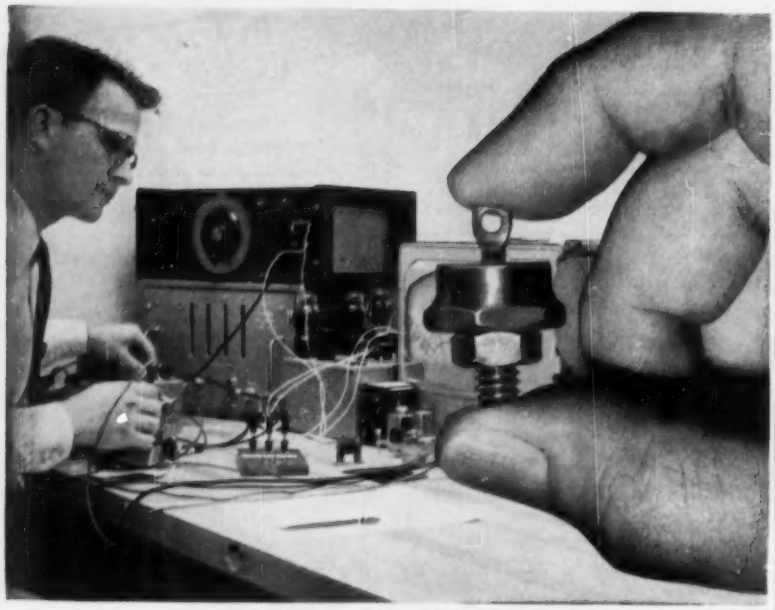
FIG. 6—Digital-to-analog voltage converter

screen of each pentode that is cut off when storing a one connected as shown. With ones stored in the flip-flops (screens cut off), the first flip-flop, which contains the most significant digit, contributes a current E_z/R, the second a current $E_z/2R$, and so on.

This binary weighting of the currents supplied by the various stages then results in a current (or voltage) proportional to the binary number stored. The only requirements placed on the tubes are that no screen current flow when a one is stored and that sufficient current be drawn when a zero is stored to cut off the associated collector diode, with resultant zero current contribution.

Use of silicon diodes as collectors reduces the back current of a cut-off diode to a negligible value, while offering a very small resistance in the forward direction. The accuracy of the circuit is chiefly dependent on the tolerances of the resistors and the ability of the regulating diode to maintain a constant voltage E_z. The most critical resistor is the one associated with the first flip-flop, which should have an accuracy of at least 1 part in 2^n.

Since highly precise resistors are available, the limiting factor will normally be the regulating diode, which must compensate for varia-



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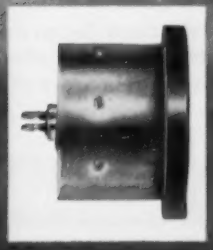

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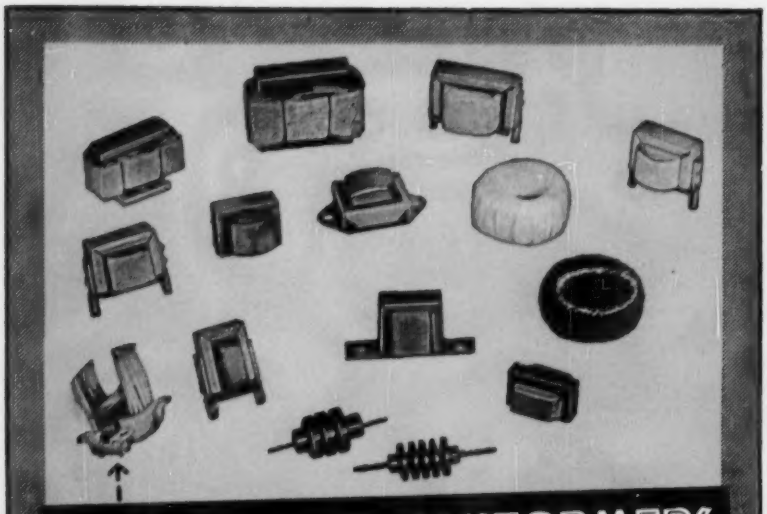

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tions in the supply voltage as well as a total variation $2E_s/R$ in the output current. By choosing the proper diode and operating it at a suitably high current, variations in E_s can be held sufficiently low that the circuit can be made good to 8 digits, which implies an accuracy of 1 part in 256.

Reflection-Type Asymmetrical Waveguide

By KORYU ISHII
Microwave Laboratory
Nihon University
Surugadai, Tokyo, Japan

ONE-WAY TRANSMISSION waveguides using ferrite and resistive film attenuators depend on Faraday rotation of the electromagnetic wave. Waves in the forward direction may pass through the waveguide without high attenuation but waves in the opposite direction are absorbed by the resistive film and cannot pass.

A reflection-type asymmetrical waveguide described here uses a combination of *H*-plane tapered iris and matching screws. Figure 1 shows a diagram of the reflection-type asymmetrical waveguide.

The *H*-plane tapered iris made of thin metallic film is located in the rectangular waveguide. This iris determines direction of power transmission. The discontinuity of

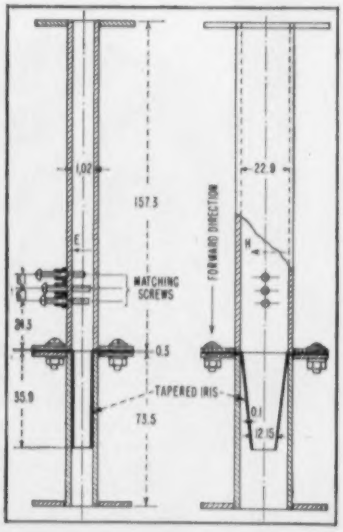

FIG. 1—Cross-section of asymmetrical waveguide in the *E* and *H* planes

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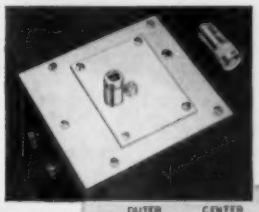

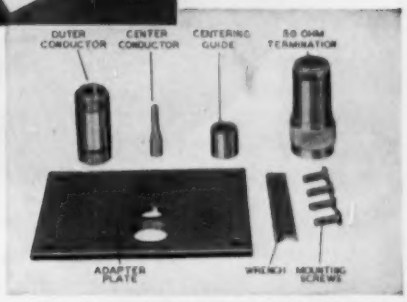

Co-ax Adapter Kit Type 515-A adapts RX Meter for coaxial connections.

TYPE 250-A FREQUENCY RANGE 500 kc to 250 mc

The RX Meter Type 250-A is a completely engineered measuring instrument including a broad band RF oscillator, RF bridge and null detector. The parallel resistance and parallel capacitance or inductance of the unknown is indicated on precise, easily-read dials. Components such as resistors, capacitors or coils, are connected across two unbalanced binding post connections on top of the instrument. The Co-ax Adapter Type 515-A, shown above, replaces the binding posts in a few seconds with a Type N Connector for measurement of coaxially connected devices. No corrections are necessary over the entire frequency range for most measurements.

Dynamic measurement of a junction transistor under conditions of variable bias and applied RF. Similar procedures can be used with vacuum tubes.

The RX Meter measures the characteristic impedance, attenuation and propagation velocity of RG-58/U Cable.

The RX Meter provides a simple, accurate means of measuring, independently, the RF resistance and reactance of a wide variety of materials, components and circuits. It is also useful in making other types of measurement.

Dynamic measurements of the parameters of transistors and vacuum tubes can be made. D.C. current up to 50 ma can flow through the bridge terminals permitting simple direct biasing of the unknown element. By a simple procedure, the RF voltage across the unknown can also be varied, permitting measurement of input and output impedance under a wide variety of conditions.

Cable characteristics can be measured on the RX Meter using a very short cable sample. A simple measurement will yield the characteristic impedance, attenuation and propagation constant. By the use of a balun the same characteristics can be measured for balanced cables.

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CAPACITANCE RANGE (Cp): −100 mmf to +20 mmf (may be extended).
INDUCTANCE RANGE (Lp): 0.001 uh to 100 mh.
TEST VOLTAGE: 0 volts D.C. (Up to 50 ma may be passed through unknown terminals). 0.1–0.5 volts R.F. (may be conveniently reduced to 20 mv).
POWER REQUIREMENTS: 105–125 volts, 50/60 cps, 60 watts (internally regulated).

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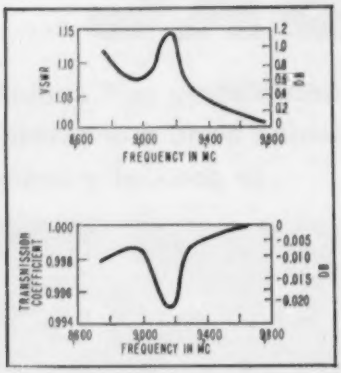

FIG. 2—Frequency characteristic of reflectionless termination

the iris for forward transmission is compensated by matching screws.

Operation in the forward direction is as follows. Transverse *H*-plane width of the narrow mouth of the iris is shorter than the half of the cutoff wavelength. Therefore, even if the iris is made of tapered waveguide and the impedance is gradually transformed, this section acts as a discontinuity. This discontinuity is, however, compensated with matching screws.

If the wave comes from the opposite direction, power cannot pass the narrow mouth of the iris. Because this size is below cutoff and since there is no matching device the discontinuity of the narrow mouth is not compensated. Matching screws at the right side do not act in the field free region this time.

Wave power transmission coeffi-

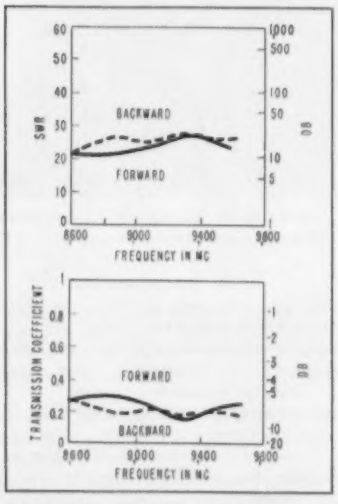

FIG. 3—Transmission characteristic of tapered iris in both directions

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✳ **Seawolf Launching Invocation,** July 21, 1955, by Lt. Comdr. Paul F. Bradley, (ChC), USN. "Therefore, reverently we ask Thee, O God, of both the atom's law and man's reason, to bless and guide them to life more abundant . . . to peace . . . because the awful alternative is the end of all life."

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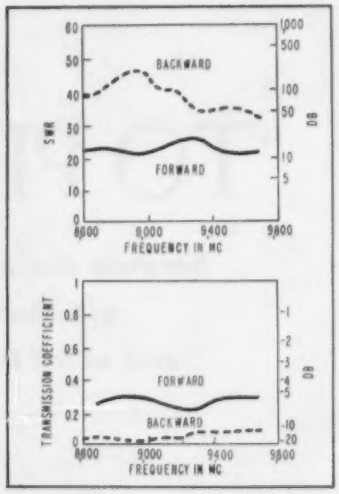

FIG. 4—Characteristics of matching transformer section of asymmetrical waveguide

cients of this asymmetrical waveguide were measured by conventional method using a standing wave detector and reflectionless termination.

Figure 2 shows the frequency characteristics of the reflectionless termination. The vswr is less than 1.15 and the power transmission coefficient is more than 99.5 percent over the range of 8,700 to 9,700 mc.

Transmission characteristics of a section of the tapered iris alone is shown in Fig. 3. The wave transmission is asymmetrical but the forward transmission coefficient is too small.

Figure 4 shows the transmission

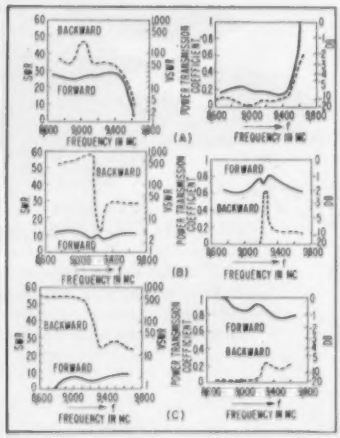

FIG. 5—Characteristics of complete waveguide adjusted for maximum forward transmission (A) and optimum transmission coefficients at 9,180 mc (B) and 8,785 mc (C)

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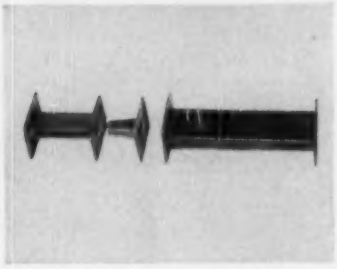


Three sections of asymmetrical waveguide before assembly. Tapered iris is at center

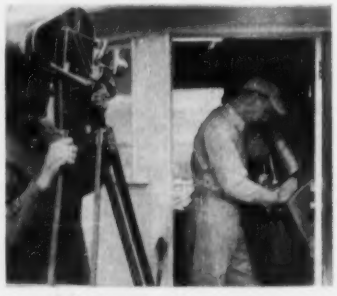
characteristics of the matching-screw section. This section is almost symmetrical.

With the iris section and the matching-screw section combined the power transmission characteristics is as shown in Fig. 5. In Fig. 5A, the matching screws were adjusted to obtain maximum forward power transmission coefficient at 9,615 mc. Fig. 5B and Fig. 5C show optimum transmission coefficient at frequencies of 9,180 mc and 8,785 mc, respectively.

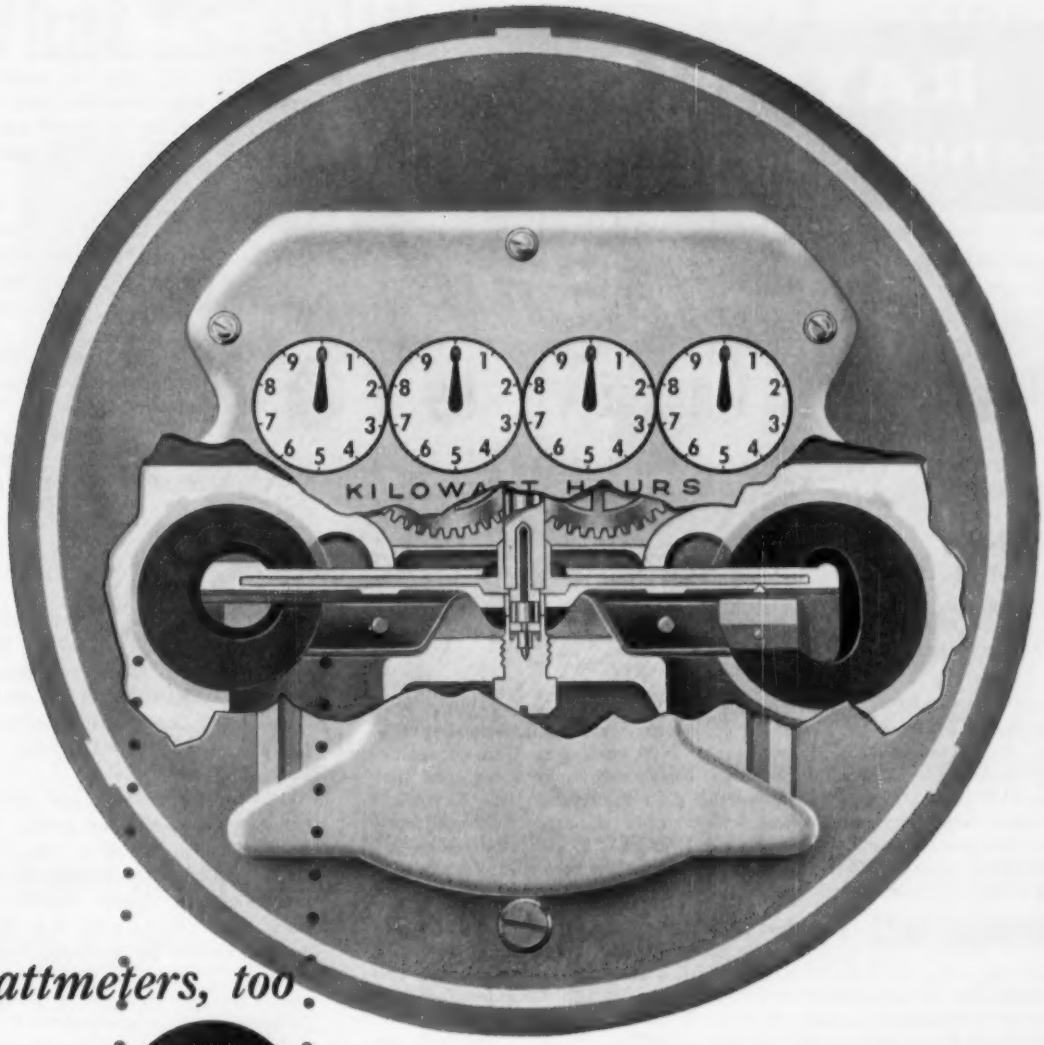
For Fig. 5A, the backward transmission coefficients were also improved by the matching screws but the asymmetrical nature of the waveguide is not so good.

In the case of Fig. 5B, the asymmetrical nature of the waveguide is very good over the range of 8,790 to 9,270 mc. Resonance due to both the tapered iris and the screw tuners are observed at 9,250 mc and forward attenuation is a bit

Radar Movie



A twenty-minute motion picture film called "Safe Passage" produced by Raytheon Mfg. Co., Waltham, Mass., shows some of the faulty techniques that have resulted in collisions between ships equipped with radar. Made with the assistance of the Coast Guard and others, the sound film is available on loan for education



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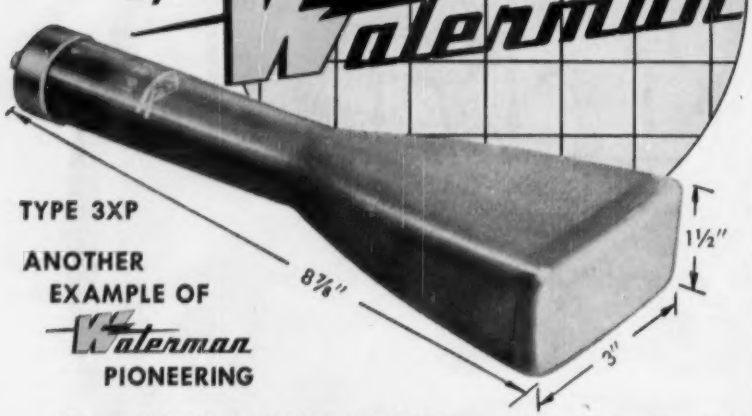

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TECHNICAL DATA The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table below. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.

TUBE	PHYSICAL DATA			STATIC VOLTAGE			DEFLECTION*		LIGHT OUTPUT**
	Face	Length	Base	A3	A2	A2 Max.	Vert	Hor	
3JP1	3"	10"	Med Diheptal	3000	1500	2000	111	150	352
3MP1	3"	8"	Sm Duodecal		750	2500	99	104	33
3RP1	3"	9⅛"	Sm Duodecal		1000	2750	61	86	44
3SP1	1.5x3"	9⅛"	Sm Duodecal		1000	2750	61	86	44
3XP1	1.5x3"	8⅞"	Loctal		2000	2750	33	80	218

*Deflection in volts per inch.
**Light output of an element of a raster line (one mm long and not exceeding .05mm in width) in microlumens.

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high for some purposes.

In Fig. 5C, the asymmetrical nature is best over the frequency band from 8,700 to 9,200 mc. In this range, the forward attenuation is less than 0.8 db.

At frequencies higher than 9,250 mc the cutoff effect of the tapered iris is not as effective for backward transmission and asymmetrical nature is weakened. In the useful range of the frequencies, high standing-wave ratio for backward transmission shows part of the incident wave power is reflected.

The author wishes to thank K. Owaki, S. Sonoda, I. Yokochi, Kenichi Fujinawa, Takeshi Hara and Nobuyoshi Watanabe.

Testing UHF DX

AN EXPERIMENTAL beyond-horizon circuit has been set up by Radio Corporation of America in co-operation with RCA Victor Ltd. of Canada, linking Covey Hill, Huntingdon County, Quebec, with Riverhead, L. I., N. Y.

Put into operation last August, the circuit spans 288 miles. Frequency of operation is 468 mc, so that propagation is necessarily by means of tropospheric scatter. The parabolic antenna used is a 40-foot dish mounted on a 50-foot tower. Covey Hill, most northerly peak of the Adirondacks, has an elevation of 1,100 feet.

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Forty-foot parabolic antenna beams RCA signals from Canada to Long Island in test of long distance uhf propagation

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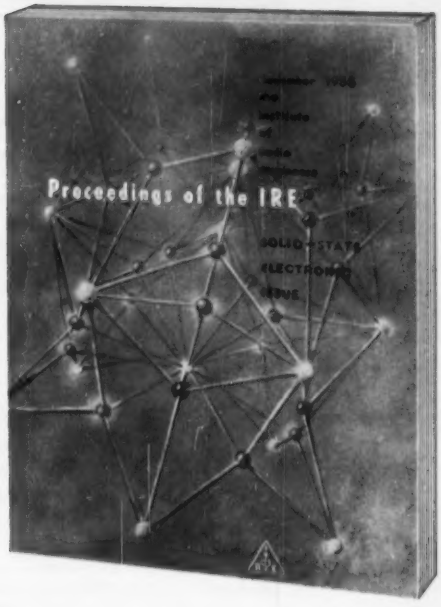

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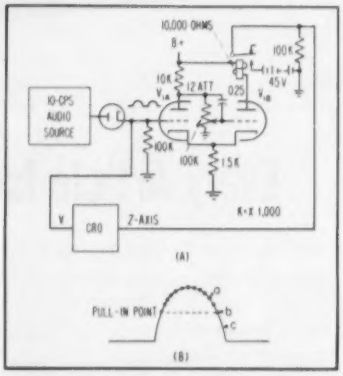
much of which results from a high antenna gain. RCA engineers stress the fact that this circuit is experimental, for data gathering and is not currently in use for communications.

The over-horizon technique is particularly applicable in remote regions where the cost of maintaining conventional microwave repeaters every 25 or 30 miles would be either prohibitive or physically impossible.

Zero Hysteresis Relays

By IRVING BARDITCH
Baltimore, Md.

USE OF A RELAY that has identical values of pull-in and drop-out current is sometimes mandatory. Almost any relay can be made to do this in combination with the proper

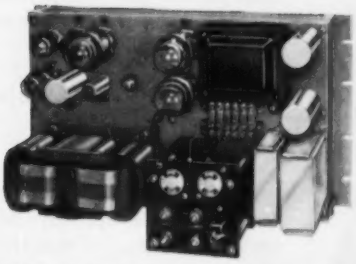


Circuit for comparing pull-in and drop-out voltage of relays (A). Oscilloscope waveform (B) shows position of closure point for early drop-out *(a)* equal pull-in and drop-out *(b)* and late drop-out *(c)*

vacuum-tube drive circuit. A zero or even negative hysteresis can be obtained.

The circuit diagram shows the trigger circuit with the relay in the plate of V_{1B}. Adjustment of the bias on V_{1B} allows the relay drop-out current to be made equal to, less than or greater than the pull-in current. A 100,000-ohm potentiometer permits this adjustment to be made without difficulty.

The set-up shown allows the relay action to be shown on the scope. The half-wave sinusoid pulses at a 10 to 20-cps rate drive the relay and present the pattern on the scope



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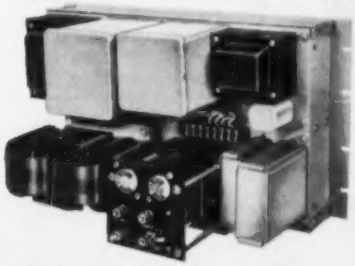

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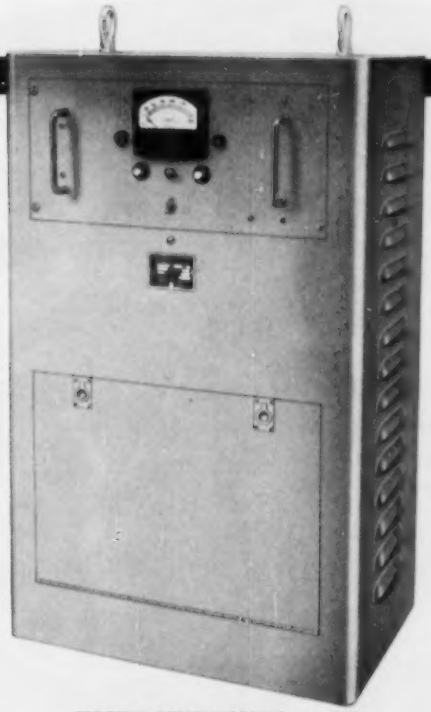

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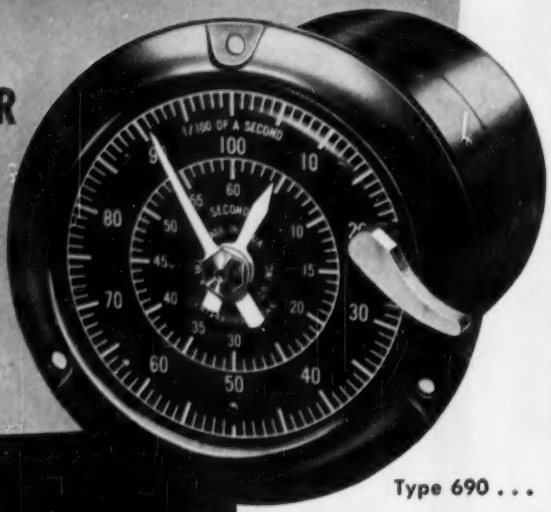

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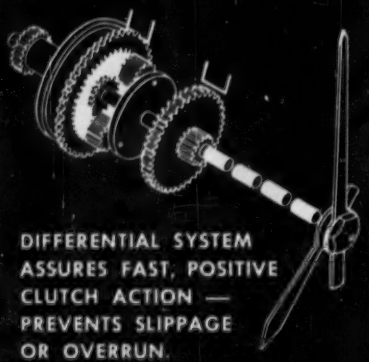

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that is blanked during relay closure. This shows the exact timing for opening and closing of contacts.

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CONTROL of a modern television receiver by a flashlight depends upon selection of an appropriate photosensitive target. Photocells located near the four corners of the television screen determine clockwise and

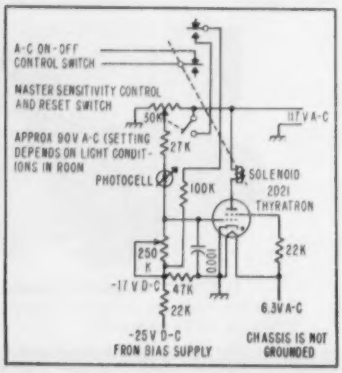

FIG. 1—Thyratron control circuit used for power switch and muting

counterclockwise channel selection, operation of the power switch and sound muting. Sensitivity, volume control and other adjustments must be manually preset.

Photoelectric devices used are cadmium-sulfide photocells. They change resistance with change in light. Resistance is an inverse function of light intensity, being extremely high in the absence of light. The range may be as great as 100 megohms to 25,000 ohms.

Two different types of controls are used. The motor drive unit is actuated through a pair of thermionic motor-control tubes (both in the same envelope) and relays. Loudspeaker muting and power switching is handled using a pair of thyratrons.

When the control grid of the 2D21 thyratron in Fig. 1 is near zero, conduction occurs. Since the plate voltage is alternating, the tube stops conducting every time the a-c swings negative. Alternating voltage applied to tube plate and control grid are in phase and tube conduction occurs during the positive

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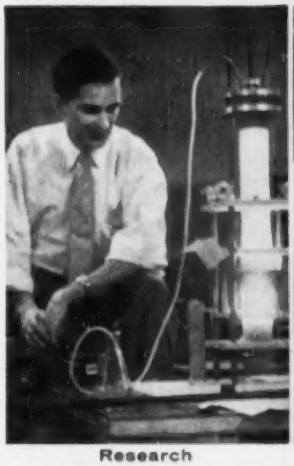

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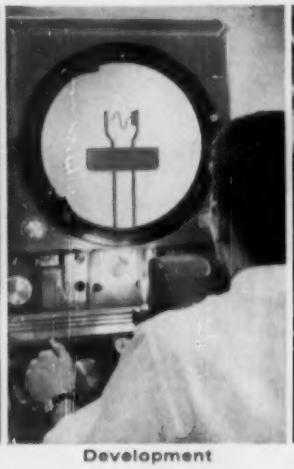

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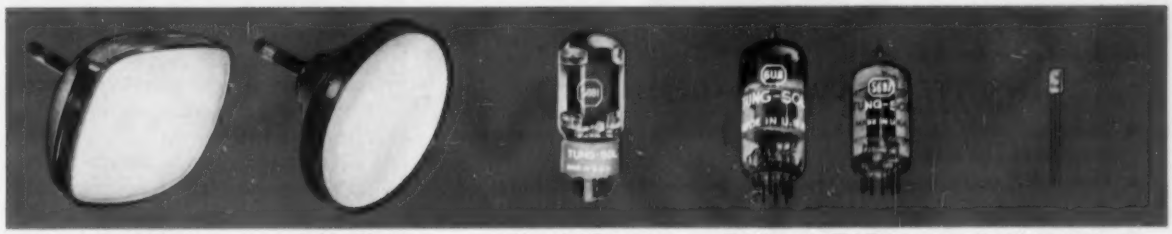

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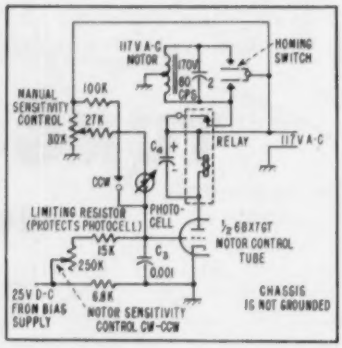


FIG. 2—Motor control circuit selects channels

swing. The plate-circuit solenoids are energized by pulsating direct current.

Since the photocell decreases resistance when illuminated, the thyratron will fire owing to rising potential on the control grid, energizing the solenoid that performs the appropriate switching function.

Action of the tuning motor control circuit is similar to the thyratron action. Because only momentary contact and release are required, plate-current relays are operated by conduction of either half of a dual-triode 6BX7 tube, as shown in Fig. 2.

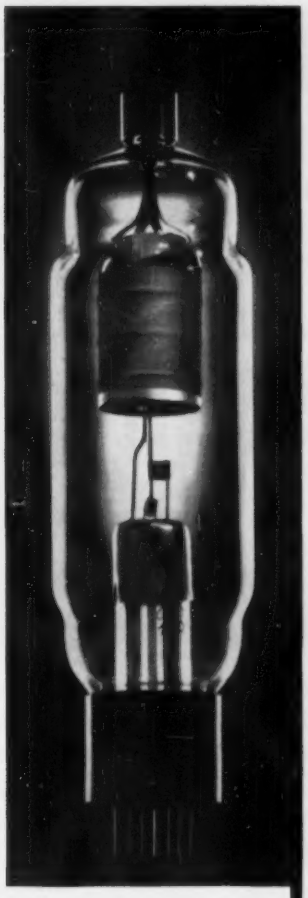
When the amplitude of a-c control voltage swings the grid of the tube sufficiently positive for an average 9-ma rectified direct-current flow through the coil the relay will operate. With no excitation voltage at the grid, no d-c plate current will flow since the tube is normally biased to cutoff.

Filter capacitors C_a and C_b smooth out the pulsating voltage and avoid relay chatter that would otherwise result during negative swing of the alternating current.

Information on the Zenith Flashmatic remote control has been abstracted from an operating guide furnished through the courtesy of Zenith Radio Corp.

Volscan Evaluation

AIR TRAFFIC control tests will be conducted for Air Research and Development Command by engineers of Air Force Cambridge Research Center. Evaluation of the Volscan (AN/GSN-3) system will be conducted at Clinton County Air



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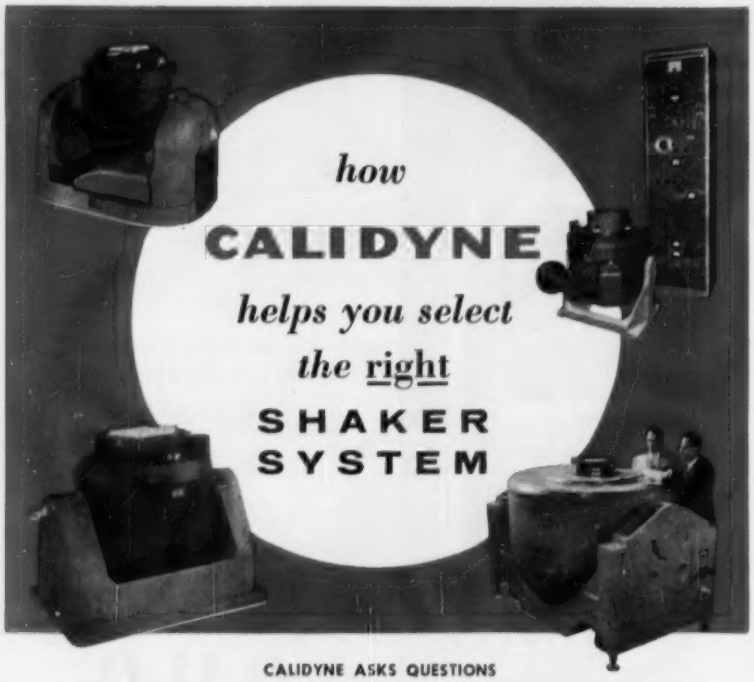

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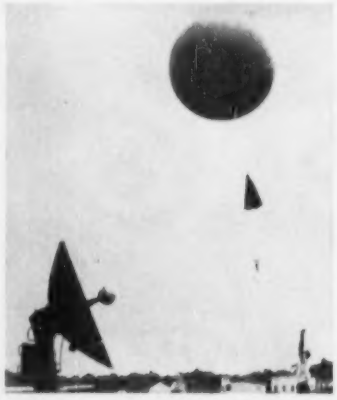
Dynamic Characteristics of Triode-Connected Pentodes

By ALEXANDER J. DESSLER and H. G. ROBINSON
Duke University
Durham, North Carolina

APPROXIMATION formulas accurate to within 20 percent are given in this article for the μ, g_m and r_p of triode-connected pentodes utilizing

Faster Radiosonode



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Demonstrations of a new equipment, designed in Cambridge, have been given in London recently to representatives of Police and Fire Services, Local Authorities and Industrial Organisations. This equipment has been designed to defeat the chronic shortage of two-way radio channels.

Known as the Pye "Ranger" it is the solution to the frequency shortage which is hamstringing mobile radio users in Great Britain!

The new equipment operates on a channel spacing of only 25Kc/s—a quarter of the customary spacing—thus potentially quadrupling the number of mobile radio channels. Robust construction, excellent performance and carefully selected components make it capable of operating under arduous conditions and in any weather.

This mobile radio is designed for fitting in the dashboard of ordinary cars and vehicles. The price of the equipment, notwithstanding its many-times improved specification, is approximately the same as that of earlier equipments which it now replaces.

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only readily obtainable pentode-connected data. A formula is also given for the dynamic screen-grid resistance of a pentode.

The formulas, based on the approximations that the characteristic curves are linear in the vicinity of the quiescent operating point and that the shielding of the screen grid essentially prevents changes in the plate voltage from affecting the cathode current, give the dynamic characteristic values for triode-connected pentodes:

$$g_{m,T} \approx \left(1 + \frac{I_s}{I_b}\right) g_m$$

$$r_{p,T} \approx \frac{E_s}{(I_b - g_m E_c)\left(1 + \frac{I_s}{I_b}\right)}$$

$$\mu_T \equiv \frac{g_m E_s}{I_b - g_m E_s}$$

$$\mu_T \approx (g_{m,T})(r_{p,T})$$

where

$g_{m,T}$ = triode-connected transconductance
μ_T = triode-connected amplification factor
$r_{p,T}$ = triode-connected dynamic plate resistance
g_m = pentode-connected transconductance
I_s = d-c pentode screen grid current
I_b = d-c pentode plate current
E_s = d-c pentode screen grid voltage
E_c = d-c control grid bias (negative) or $-R_k(I_b + I_s)$ when the cathode bias resistor, R_k is given.

The following is an example using the 6AK5 sharp-cutoff pentode. The pentode connected data for typical operation is obtained from the tube manual.

$g_m = 5{,}000\ \mu\text{mhos}$
$I_s = 2.5\ \text{ma}$
$I_b = 7.5\ \text{ma}$
$E_s = 120\ \text{v}$
$E_c = -R_k(I_s + I_b)$
$= -180(10 \times 10^{-3}) = -1.8\ \text{v}$

$$g_{m,T} \approx \left(1 + \frac{2.5}{7.5}\right) 5{,}000 = 6{,}700\ \mu\text{mhos}$$

$$\mu_T \approx \frac{5{,}000 \times 10^{-6} \times 120}{7.5 \times 10^{-3} + 5{,}000 \times 10^{-6} \times 1.8} = 36$$

$$r_{p,T} \approx \frac{120}{(7.5 \times 10^{-3} + 5{,}000 \times 10^{-6} \times 1.8)\left(1 + \frac{2.5}{7.5}\right)} = 5{,}400$$

The plate voltage for triode operation should equal the pentode operated screen voltage; also the triode-connected control-grid bias should remain the same as that on the pentode.

Higher order correction terms added by more exact analysis were not included since for design pur-

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Finely divided plastic solid in volatile medium. Applied by spray, spread or dip coating. KEL-F Dispersions give metallic and other surfaces the corrosion resistance and non-adhesive, non-wettable characteristics of KEL-F plastic. Coating formed is dense, tough, chemically resistant. Applications include: component coatings, dielectric shields, insulation on instruments and apparatus.

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KEL-F Oils, Waxes and Greases are low molecular weight polymers. Resistant to chemicals, heat, cold, and are non-flammable. Oils are fluid at room temperature. Waxes are solid at room temperature. Greases are compounded from oils and filler. Lubricity of oils is equivalent to extreme pressure additive. Applications include: lubrication, hydraulic fluids, heat transfer, damping, potting.

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Fluorocarbon base printing inks, are resistant to moisture, corrosive chemicals and gases, and abrasion. Produced in range of 10 colors. KEL-F Printing Inks are recommended for striping polyethylene, nylon and KEL-F wire insulation. Combining effectively with the substrate, they offer high performance under difficult conditions.

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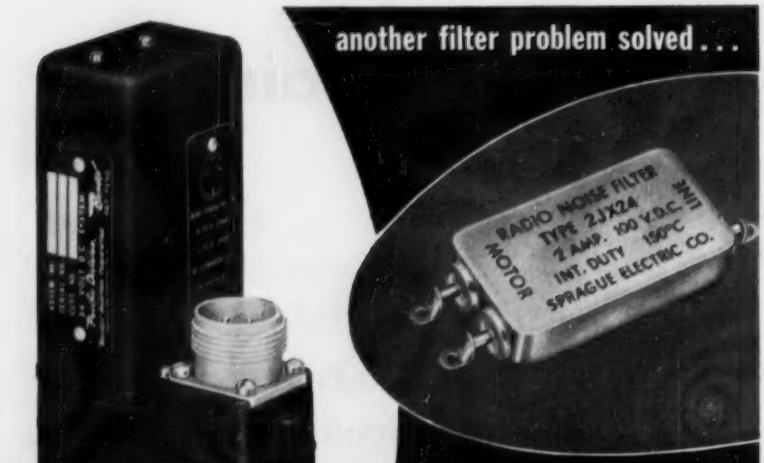

R-F NOISE ELIMINATED IN BENDIX VALVE ACTUATOR

PROBLEM: Bendix Aviation Corporation's Pacific Division, North Hollywood, California, manufactures a series of rotary electric actuators for operating valves in aircraft. But getting a small, lightweight filter to keep the motor from creating radio-frequency interference proved to be a real problem. Any such filter would have to be mounted as an integral part of the square motor actuator, and the required 150°C operating temperature didn't help any.

APPROACH: Bendix Pacific engineers took their problem to the Radio Noise Suppression Laboratories of the Sprague Electric Company in Los Angeles. There, Sprague and Bendix engineers cooperated in making radio interference measurements and setting up envelope and mounting provisions for the proposed filter.

SOLUTION: A filter was designed by Sprague to meet the envelope, mounting and 150°C performance needs. The filter successfully passed radio interference requirements of MIL-I-6181, MIL-1-6181B, and also, the rigid requirements of MIL-E-5272A. When mounted, the Sprague filter is completely encased in the motor, with the filter terminals utilized as the motor terminal strip.

PRODUCTION SCHEDULES for these and many other filters are regularly met by Sprague plants on both coasts. We would like the opportunity to solve your problem too. Write, wire, or phone Sprague Electric Company, 12870 Panama Street, P.O. Box 66507, Los Angeles 66, California (TExas 0-7531) or North Adams, Massachusetts (MOhawk 3-5311).

Sprague on request will provide you with complete application engineering service for optimum results in the use of radio noise filters.

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poses an accuracy of 20 percent is usually sufficient.

An approximation formula for the screen resistance, r_s, of the pentode is

$$r_s \approx \frac{E_s}{\frac{I_s}{I_b}(I_b - g_m E_c)}$$

As an example, using the above 6AK5 data

$$r_s \approx \frac{120}{\frac{2.5}{7.5}(7.5\times10^{-3}+5{,}000\times10^{-6}\times1.8)}$$

$$= 22{,}000$$

In normal pentode operation r_s, with regard to a-c, is effectively in parallel with the screen dropping resistor and the screen decoupling capacitor, C_s. Therefore the minimum value of C_s necessary to achieve a given low-frequency response can be calculated. Negative feedback produced by screen degeneration can also be found by using r_s.

Radio Opens Garage Door

REMOTE control of garage doors is effected by a selection of proper radio frequency and modulating frequency using a mobile transmitter and fixed receiver connected to a motor-actuated device.

Equipment manufactured by Robot Appliances, Inc. of Dearborn, Mich. operates on one of 50 differ-

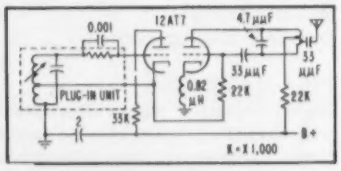

FIG. 1—Mobile transmitter

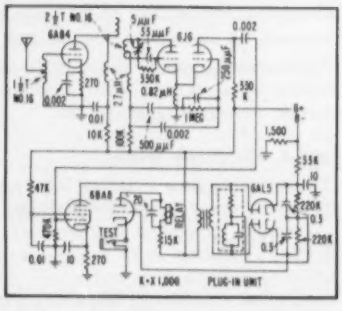

FIG. 2—Garage receiver operates motor

Hand-split mica from selected grades is scarce—almost all imported.

Treated and untreated continuous machine-made sheet mica now freely available in capacitor grades

Revolutionary new capacitor material offers cost savings up to 90%

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Better stacked capacitors at lower cost. Previously only high grades of costly natural mica could be used in stacked capacitors. Supply was, and continues to be extremely limited. Capacitor Grade ISOMICA and SAMICA, available in unlimited quantities, may now be used in many stacked capacitor applications in jet aircraft ignition and electronic systems, as well as high-powered ground radar, etc. Use of these new materials makes possible stacked capacitors which are much less costly, easy to manufacture by automatic techniques.

Better performance in rolled capacitors. In rolled capacitors, organic paper and other materials used were subject to failure at high temperatures. Capacitor Grade ISOMICA and SAMICA make possible rolled capacitors that perform well over a wide temperature range . . . in many cases mean a reduction in size and weight for the same electrical rating.

Important savings, opportunities. Capacitor Grade SAMICA is freely available in sheets 36" wide, tapes or punched pieces. Capacitor Grade ISOMICA is available in sheets 36" x 36" or fabricated pieces. They offer you manufacturing economies and lower material costs, inventory savings, new design possibilities in both miniature and large sizes, better physical and electrical properties, and alleviate dependence on foreign sources of supply.

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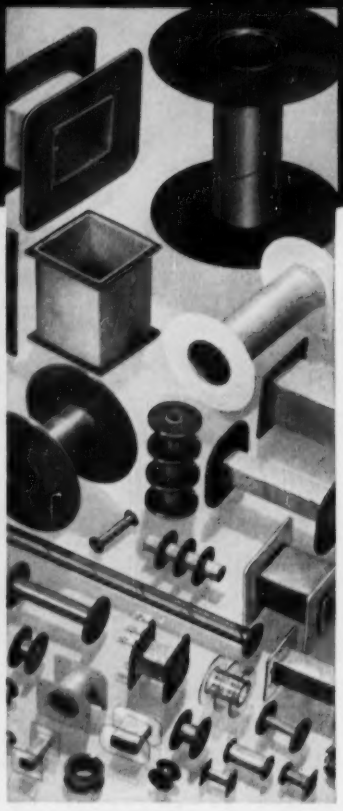

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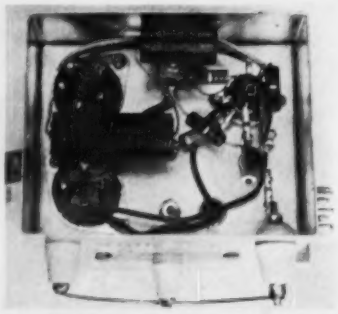
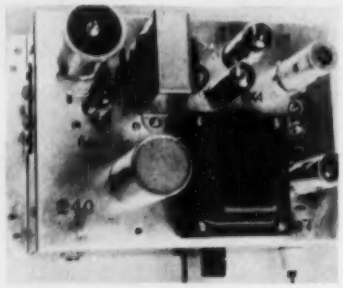


Loop is shown mounted on side of transmitter box (bottom of photograph)



Receiver that is actuated by 7-kc modulation. Equipment is mounted near door-operating motor under a dust cover

ent available radio signals. Frequencies in the same neighborhood can be staggered to avoid false operation of adjacent systems.

Besides a radio-frequency tuning control (not shown in detail) in Fig. 1, there is a plug-in audio oscillator circuit to match the discriminator in the receiver. Power is obtained from a vibrator power supply connected to the car battery.

The receiver, Fig. 2, depends both upon reception of a radio-frequency signal to which the receiver is tuned and output from an audio discriminator to operate a relay that actuates the door motor. The power supply (not shown) is conventional.

One-Man TV Camera Aligner

By W. L. SHEPARD
General Electric Co.
Electronics Park
Syracuse, N. Y.

ADJUSTMENT of either a black and white or color camera requires setting the alignment controls. This requires that the beam-focus voltage be rocked through focus setting. Normally this involves a manual adjustment at a point remote

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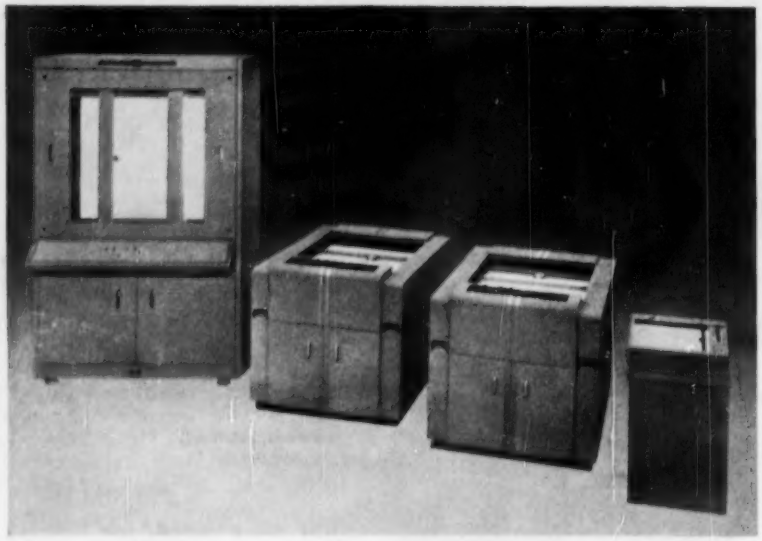
News in Analog Computing...



A choice of Plotting Boards...

A Chicago business analyst reports engineers and industries must have versatility in equipment selection, if they are to carry out the expanded research programs planned for 1956.

Foreseeing this, Electronic Associates is making available the only complete line of plotting boards. Four different models of the famous Variplotter Plotting Board, designed to give a rapid, accurate, graphic recording of any information that can be reduced to electrical form.

Reading from left to right in the picture above, there is the vertical Variplotter, Model 205J, with two arms and four pens . . . the horizontal Variplotter Model 205 K, with one arm and one pen . . . the horizontal Variplotter Model 205L, with two arms and two pens . . . and the latest Variplotter, the Model 1100 A, with one arm and one pen, and featuring small, convenient size, outstanding performance, and low cost.

For detailed information on Variplotter plotting boards, Precision Analog Computing Equipment, or rental of time at the EAI Computation Center in Princeton, New Jersey, contact Dept. EL-14. Electronic Associates, Inc., Long Branch, New Jersey.

ELECTRONIC ASSOCIATES — EAI SETS THE PACE (PRECISION ANALOG COMPUTING EQUIPMENT)

LONG BRANCH, NEW JERSEY

from the camera, requiring a second man at this remote point.

A simple circuit used in some equipment automatically eliminates the necessity for manual rocking of the beam focus. Thus the need for two men to perform the adjustment procedure is eliminated.

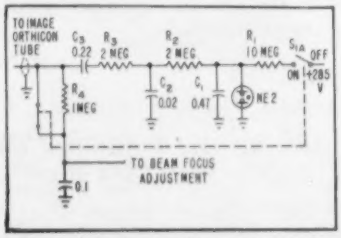
The circuit requires few parts. When switch S_{1A} is turned to the on position, voltage is applied to the circuit and the short across R_4 is removed. Capacitor C_1 charges through R_1 until a voltage high enough to fire the neon bulb is reached. Then C_1 is discharged through the bulb. The time constant of R_1 and C_1 determines the number of times per second that the beam focus is rocked through the focus position.

The resultant sawtooth is then applied to C_2 through R_2. This results in a partial integration of the sawtooth to produce a triangular waveform. This waveform is then applied through R_3 and C_3 to R_4. Resistor R_3 serves to isolate the circuit and divide the voltage to obtain the correct swing of the beam focus. The triangular waveform superimposed on the correct direct voltage causes the beam focus to go in and out of focus.

The values given will cause the beam focus to rock completely through focus approximately twice a second. This rate can be adjusted easily by changing the values of either C_1 or R_1.

It is necessary, when installing this device, to use shielded wire for any long leads going to the image orthicon tube. This prevents any tendency for feedback.

To use this device it is only necessary to adjust the beam focus voltage for best focus. Then switch S_1 is turned on. After the alignment procedure is completed, the switch is turned off and the camera then functions normally.



Circuit of the focus adjustment unit that can be mounted in the television camera

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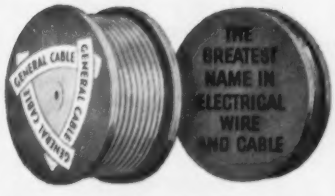

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Production Techniques

Edited by JOHN MARKUS

Plug-In Assemblies Use Standard Component Bodies

During development of a new design, engineer can make up own module by snapping components into clips, then soldering clips conventionally

Finished modules are easily inserted in punched holes of etched wiring board

PACKAGED SUBASSEMBLIES of standard composition resistors and tubular ceramic capacitors, mass-produced at an overall cost approximating that of individual components, have been announced by Erie Resistor Corp. Called PAC, for Pin Assembly Circuit, the new modules can be plugged into holes of etched-wiring boards either manually or by machine, for lower-cost tv and radio sets as well as computers, industrial controls and other military and commercial electronic equipment.

► **General Details**—The mounting base used for each module is XXXP copper-clad paper-base phenolic. Sprocket-like terminal holes are punched along both sides of long strips of the material. The strips can later be chopped into shorter lengths holding up to 92 components. After applying embossed wiring to one side of the base for interconnections, terminals are installed on the other side by automatic machinery, to make contact through the board with the embossed wiring.

The terminals are like miniature fuse clips, for holding cylindrical leadless standard component bodies. One row of terminals has integral terminal pins. The components are pushed into these clips and the edges of the board are dipped in solder, after which the assembly is given a dipped or molded plastic jacket.

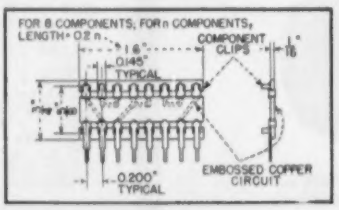

FIG. 1—Base and terminal dimensions

► **Dimensions**—The new modular assembly is based on use of uniform components $\frac{1}{4}$ inch in diameter and $\frac{3}{8}$ inch long. These outline dimensions have been standard for ceramic tubular capacitors and composition resistors for many years. Other components having these dimensions can be used equally well.

A standard center-to-center spacing between components of 0.200 inch has been selected, as shown in Fig. 1. This spacing provides maximum utilization of space, with corresponding economy of production cost both for the modules and the finished electronic equipment.

Resistors available for these dimensional requirements are rated at $\frac{1}{2}$ watt and 500 volts with tolerances of 5 percent or wider in values from 5 ohms to 50 megohms. Back-of-board wiring readily permits connecting components in series or parallel for higher wattage ratings. Capacitors are available

going...

going...

gone!

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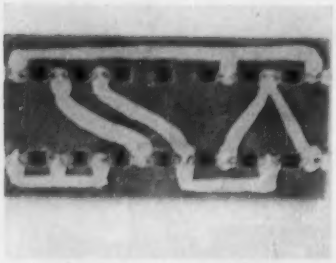
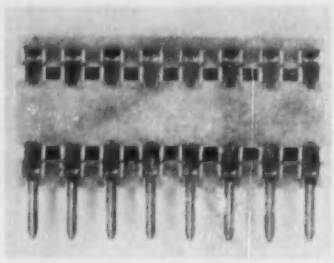
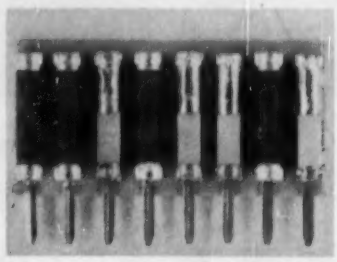


Embossed wiring on back of base

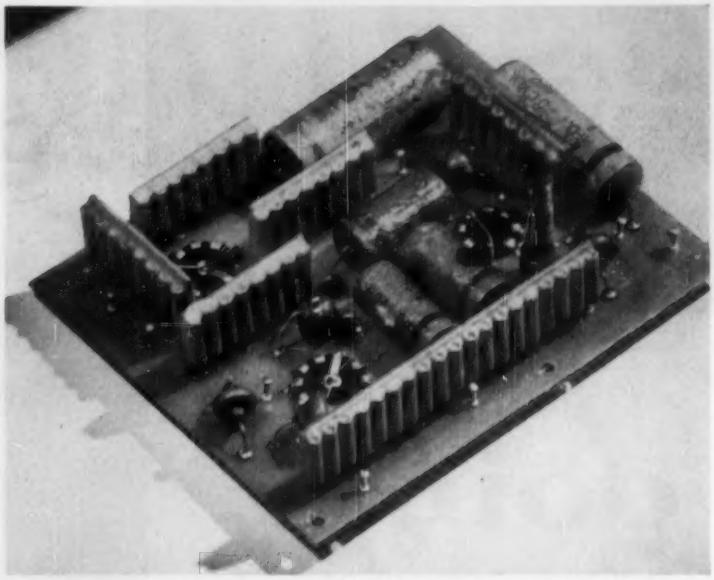


Front view of base after staking pins



Appearance after installation of component bodies and dip-soldering

Finished module in plastic jacket



Six of the new modules replace 59 individual components on this etched wiring board, reducing the original 69 insertion operations to only 16

in the range of 1 to 5,100 $\mu\mu$f.

► **Advantages**—Since each circuit element is individually made and tested prior to assembly, no compromises in characteristics and tolerances are needed. Tolerances can be as close as those available for individual components.

Individual capacitors mean complete diversity in selecting values and temperature characteristics. The same module can include low-capacitance temperature-compensating units and high-capacitance bypass units.

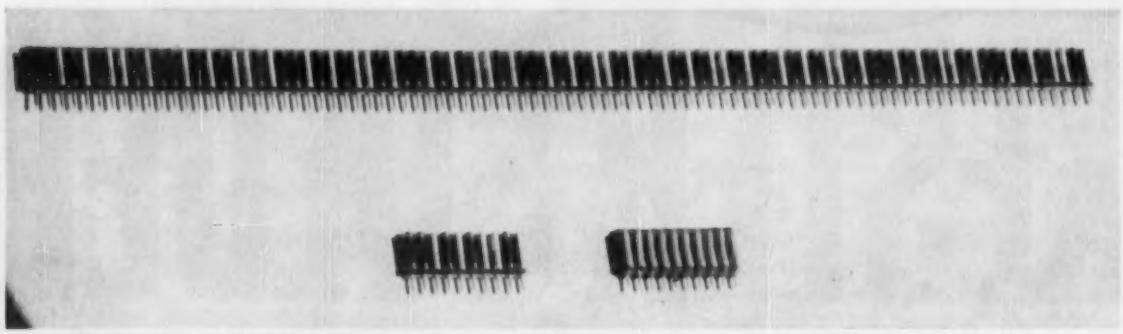
Since the components are mounted vertically with respect to the etched-wiring chassis, area requirements on the wiring board are greatly reduced. A pin-assembly circuit containing 15 components occupies only 1 sq in. of chassis area.

Design engineers can be supplied with mounting-base samples with clips attached. These, together with kits of resistor and capacitor bodies in a wide range of values, facilitate experimental breadboard layouts.

After a circuit is tooled and being produced, component value changes merely involve substituting new parts at the assembly station.

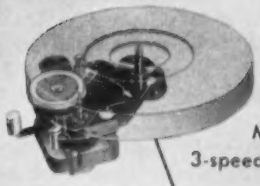
The laminated phenolic base strip insures against breakage in shipping and handling. Terminals are firmly staked to the base.

► **Wiring**—Connections between components are facilitated by embossing the copper wiring on the back of the base. This process is

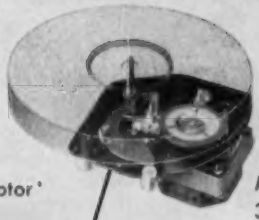


Long strip has components in position before cutoff. At lower left is section cut from strip and at right is finished module

The Only COMPLETE Line...



Model SS
3-speed, 2-pole motor



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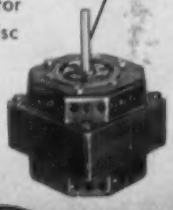


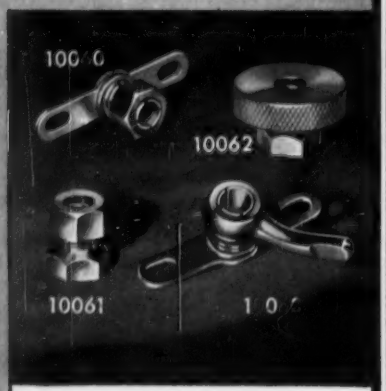
Model RM 4
Single speed,
4-pole motor

THE GENERAL INDUSTRIES CO.

DEPARTMENT GA • ELYRIA, OHIO

Want more information? Use post card on last page.

Designed for Application

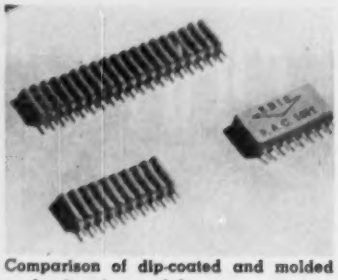


SHAFT LOCKS

In addition to the original No. 10060 and No. 10061 "DESIGNED FOR APPLICATION" shaft locks, we can also furnish such variations as the No. 10062 and No. 10063 for easy thumb operation as illustrated above. All types are available in bright nickel finish to meet Signal Corps requirements or black oxide to meet Navy specifications.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS



Comparison of dip-coated and molded packaging for modules

unique in that no chemicals are used in preparation of the circuit. The desired pattern of wiring is punched below the surface of the copper-clad laminate. Unwanted surface copper is then ground off to leave the wiring. Either 1-oz (0.00135-inch) or 2-oz (0.0028-inch) electrolytic copper foil is used.

Terminals are tinned flat stock having an enlarged portion near the unit to serve as an automatic stop for mounting. Dip-soldering gives intimate noise-free contact between terminals, contact clips, wiring and components.

The adhesive bond used with the laminate will withstand solder-dip temperatures up to 570 F for 2 seconds immersion or 500F for 10 seconds without causing blistering or weakening of the bond. When tested before soldering in accordance with NEMA standards, a peel strength of 6 to 8 lb is obtained.

Minimum line width and spacing is $\frac{1}{32}$ inch. Large conductor areas such as shields and grounds can be embossed if broken by picket-fence barriers.

After soldering, the unit is dipped or molded into a jacket of plastic for environmental protection and ease of manual or automatic handling. Finished dimensions are shown in Fig. 2.

PAC units are designed primarily for use with etched wiring boards. Components for one or several stages can be inserted in one plugging-in operation. If done manually, labor costs are drastically reduced as compared to individual insertion of components. If automatic insertion equipment is used, the number of insertion heads is correspondingly reduced.

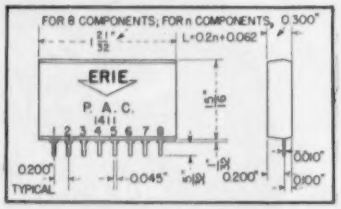
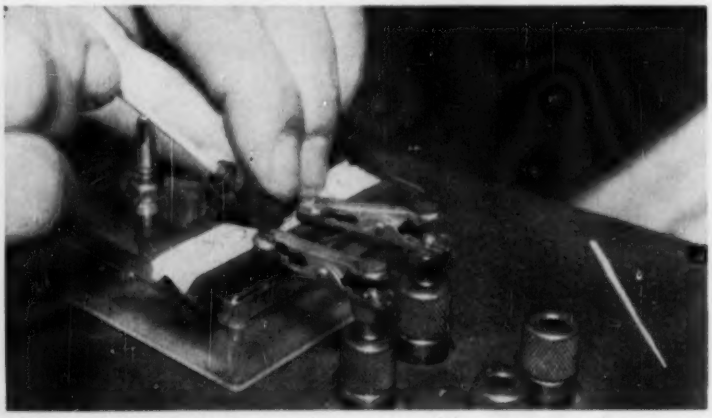


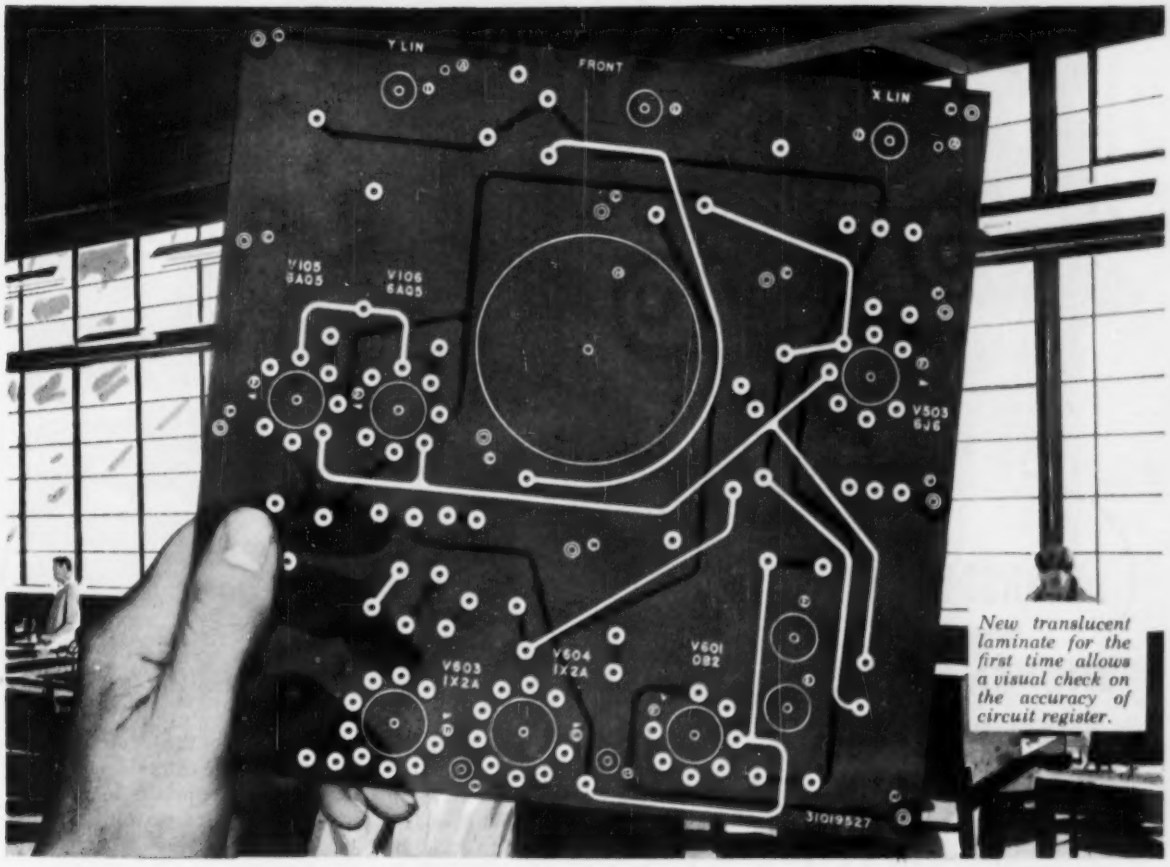
FIG. 2—Dimensions of finished unit and method of marking

Toothpicks Screwdrivers for Fragile Cores

WHEN SCREWDRIVERS snapped slot shoulders of sintered-iron cores during factory test adjustments in small coils for airborne radar, Fred Olney suggested using common toothpicks which would twist be-



Using toothpick to adjust sintered iron core while measuring inductance at production test setups



New translucent laminate for the first time allows a visual check on the accuracy of circuit register.

Formica Research perfects sensational new cold punching laminate

Brings 1,000,000 megohms resistance value, precision and translucency to printed circuitry . . . . .

Research, an important part of the exclusive new Formica 4-point service, has just perfected a new cold punching paper base laminate offering 1,000,000 megohms insulation resistance and valuable new translucent properties.

Known as XXXP-36, the new grade brings greater accuracy to printed circuitry. Because of its cold punching qualities, XXXP-36 requires no heat cycle. Therefore, the base laminate is not subject to dimensional change as in grades which must be heated before punching. This means that with Formica XXXP-36, you can now produce printed circuits with new and higher standards of accuracy.

XXXP-36 translucency can be doubly useful. Make this simple test: hold it to the light. You can see (1) the smooth, homogenous structure, the total absence of resin pockets, voids and imperfections that dissipate the insulating properties of ordinary paper base laminates . . . and (2) how perfectly the circuit on one side registers with that on the other. New XXXP-36 is ideal for terminal boards and tv insulators requiring high I. R. Formica's engineering skill can help you find new materials for new products and processes. For complete information on the new XXXP-36, or on the new "Formica-4" service, use coupon below. The Formica Co., 4640 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA®—*the most famous name in laminated plastics—Engineered for industry, Beauty Bonded for the home.*

Make the Formica Translucency Test. Send for a sample XXXP-36 printed circuit. Fill out and mail coupon today.

Gentlemen:

☐ *I'd like a sample XXXP-36 printed circuit and complete information on this new grade.*

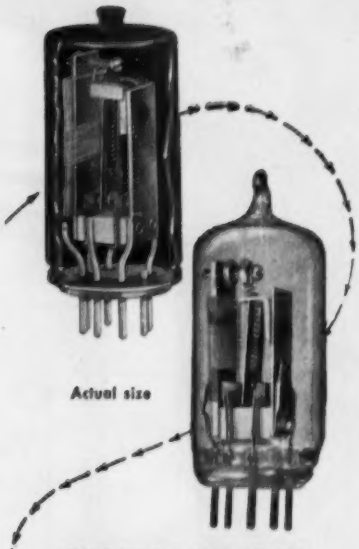
☐ *Send bulletin showing how I can take advantage of the new "Formica-4" laminated plastics service.*

Name _____

Company _____ Title _____

Address _____

City _____ Zone ____ State _____



CURTISS-WRIGHT

now offers

THE "SNAPPER" THERMAL TIME DELAY RELAY

Relied on for positive action and long life in scores of applications involving time delay in electrical circuits, the "SNAPPER," formerly produced by Elly Electronics Corp., is now a Curtiss-Wright product.

Single pole, double throw contact action eliminates chatter. These unique relays feature snap action, double throw, reliability, small size. They are adaptable to military and commercial applications. Time delay periods: preset from 3 seconds up. Envelope: metal, miniature (7 and 9 pin) or octal (8 pin). Glass, 9 pin only.

High-Low Differential Thermostat

The "SNAPPER" Thermostat is a single pole, double throw snap action temperature sensitive switch. Its snap action principle has been extended to provide a low differential thermostat with precision characteristics, at low cost.

Write for detailed data

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION · CARLSTADT, N. J.

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fore they snapped the shoulders and ruined the coils. The idea brought him a $225 suggestion award at General Electric's Light Military Electronic Equipment Dept. in Utica, N. Y.

Router Cuts Curves In Wiring Boards

Placing board on template. Dust-collecting duct is at left of router

FINISHED etched wiring boards are cut to irregular shapes with the aid of a unique production setup involving a steel template and a router, in the Glen Cove, N. Y. plant of Photocircuits Corp. Each board in turn is placed over two positioning pegs on the template and the combination is then run under the router. A metal button directly under the router on the table of the machine serves as a stop for the template to give the required shape of cut without dulling the cutter through contact with the template.

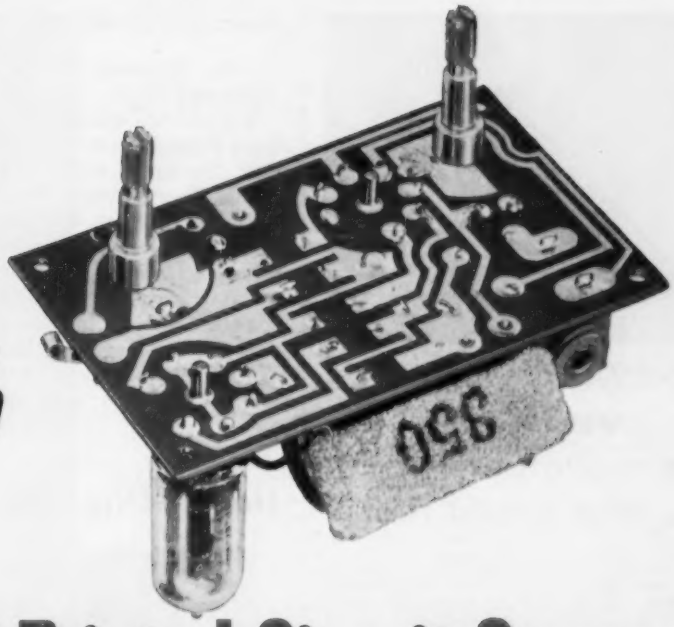
A stream of compressed air is directed at the router to blow cut particles into a vacuum collecting duct just behind.

One-Way Pallet-Return Conveyor

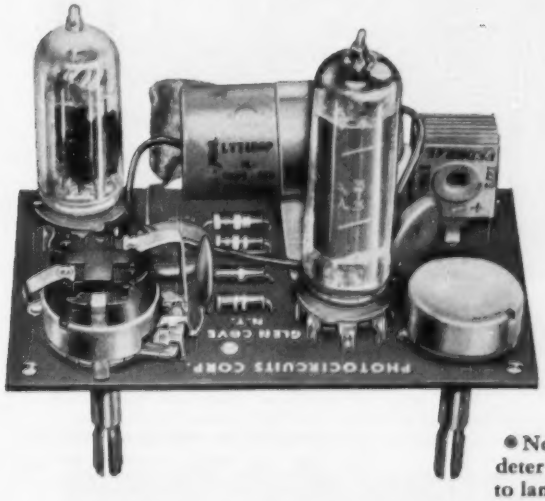
WHEN a new radio assembly line was first set up in Westinghouse's Metuchen, N. J. plant, delays were caused by the return of empty pallets to the start of assembly lines. With benches and equipment already installed, overhead and aisle space was at a minimum for me-

Hooks of empty pallet ride on rotating screw of monoflow conveyor

Speed up production with



REVERE ROLLED Printed Circuit Copper



Audio amplifier unit by Photocircuits Corp., Glen Cove, N. Y., using Revere Rolled Printed Circuit Copper.

Available NOW!

● Now that Revere *Rolled* Printed Circuit is available, nothing need deter you from switching to printed circuitry. This copper is supplied to laminators in standard coils of 350 lbs., in widths up to 38", and in .0015" and .0027" gauges, weighing approximately 1 oz. and 2 oz. per square foot.

High in conductivity, uniformly dense through and through and side to side, Revere *Rolled* Printed Circuit Copper is easily etched and soldered.

When ordering blanks from your laminator, specify Revere *Rolled* Printed Circuit Copper.

REVERE

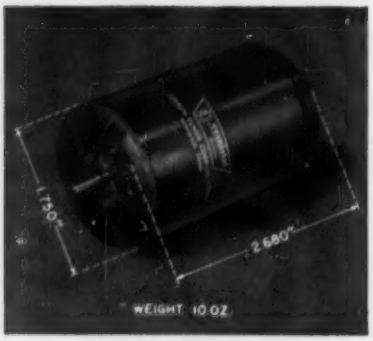
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.



NEW...the 400 cycle

vernistat*

a.c. Potentiometer

you asked for!

The 400 cycle Vernistat is an a.c. potentiometer-type voltage divider that combines *high* linearity and *low* output impedance. It is essentially a non-dissipative element adaptable to high temperature operation. Size and mounting dimensions are designed to the BuOrd specification for a size 18 synchro.

Here are the details:

- **high linearity,** inherent in the design principle, is *maintained* over the life of the unit.
- **low output impedance** eliminates need for isolation amplifiers in many applications.
- **high output current capability.**
- **low phase shift** – less than 90 seconds, depending on model.
- **can be coupled with synchros,** resolvers and other components – as well as ganged.
- **nonlinear functions can also be generated.**

Class 5 ball bearings, centerless ground shaft, and an aluminum housing machined to close tolerances combine to make the Vernistat a precision instrument. Shaft seals will be supplied where they are required by environmental conditions.

check these specifications:

Linearity Tolerance	±0.05%
Minimum Output Voltage Increment	0.01%
Output Impedance	less than 130 ohms
Input Voltage	130 v max.
Input Impedance	up to 75,000 ohms

*Trademark

vernistat
division

PERKIN-ELMER CORPORATION
Norwalk, Connecticut

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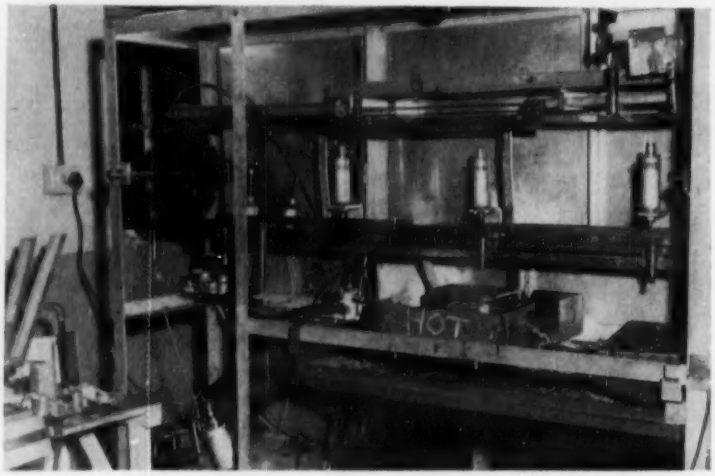
chanical handling of the pallet-return operation.

The problem was solved by ordering a rotating-cable conveyor 60 ft long, equipped with ½-hp motor drive. The conveyor extends the full length of the workers' bench lines at a convenient height of about 2½ ft above bench level. The conveyor consists of a flexible carbon-steel screw ¾ inch in diameter that turns in a metal retaining rail. The top of the rail is open to expose this screw. The wire hooks of empty pallets are hooked over the screw and are moved at approximately 12 feet per minute to a point at the start of production. These pallets can be placed on the conveyor at any time, at any point, in one motion.

This type of rotating conveyor eliminates the need for a return strand or loop, thus permitting installation in minimum space. The conveyor was designed and installed by M-H Standard Co., Jersey City, N. J.

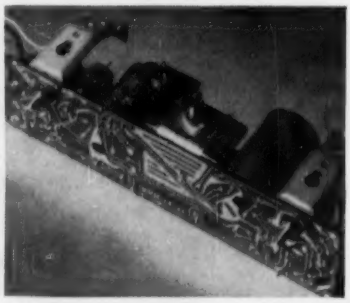
Double-Dip Soldering Uses Chassis Vibrator



Conveyorized dip soldering machine is operated by long air cylinder mounted horizontally at upper left. Assembled wiring board is taken from end of assembly line at left and hooked over bracket on lower chain. The three vertical air cylinders push the board down at the spray fluxing station (left), the soldering station (center) and the unloading or cleaning station (right)

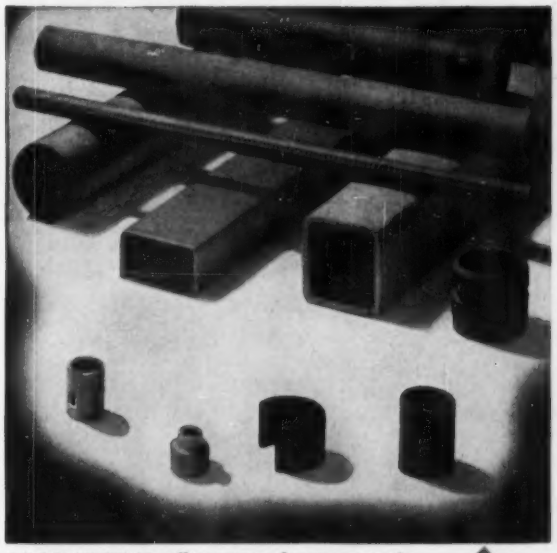
By W. R. Cass
Pye Ltd., Radio Works
Cambridge, England

A DIP soldering machine developed for use on radio etched wiring boards uses an overhead-chain conveyor driven intermittently by a long air cylinder. At the feed position, the operator hooks each assembled wiring-board pallet in turn onto brackets on the chain. The chassis is first moved to a flux spray position, then is given two dips in molten solder. During each dip and for a short period thereafter, the chassis is vibrated by air hammers to help break down oxide film on joints and to remove any excess solder.



Appearance of board after soldering. Rubber caps protecting control shafts have been removed. Keyhole slots on brackets are used to attach chassis to carrier of soldering machine

Instead of having the chain conveyor dip down at each station, an air cylinder is mounted above each station. When the chain has come



C-D-F SPIRAL TUBING offers many advantages to the cost-conscious design engineer and purchasing agent. It is low-cost, moisture-resistant, high-strength, and easy to fabricate. It has sufficiently low dielectric loss properties and good dielectric strength for many applications.

New C-D-F Plastic Spiral Tubing reduces unit costs, improves products

Using C-D-F's new Spiral Tubing is a way of saving money in buying electronic insulation . . . without lowering the electrical and mechanical characteristics of the part required. This special tubing is a high-strength plastic made from paper or vulcanized fibre that is spirally wound. It is available in two basic forms in various grades: (1) as plain untreated tubing. (2) as impregnated tubing containing various types of thermosetting insulating varnishes.

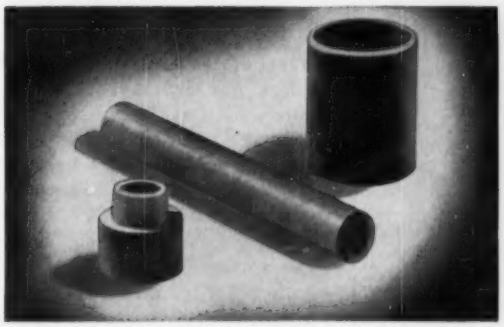
BUY ONLY THE PROPERTIES YOU NEED

Spiral Tubing can be used to replace rolled or molded laminated phenolic tubing in many cases. As the degree of moisture resistance and mechanical strength is established during the manufacturing process, you specify . . . and buy . . . only those properties required for the application. C-D-F also offers complete designing, machining and assembly. You can get finished components, or random length tubing, with fast deliveries. Write for Technical Folder ST-53 and samples, after checking our catalog in Sweet's Design File. Call the C-D-F sales engineer listed there—he can save you time and money immediately with C-D-F Spiral Tubing!

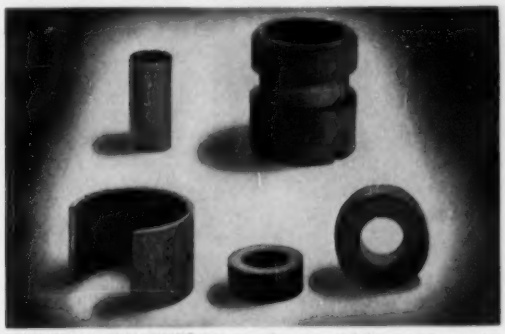
CDF

Continental-Diamond Fibre

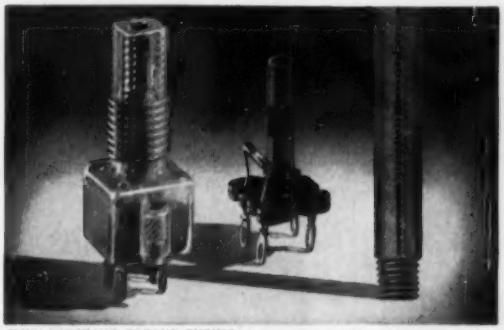
CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 16, DELAWARE



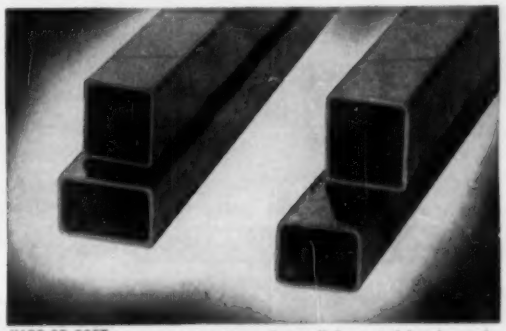
A VERY HARD TUBE is supplied in C-D-F Grade 6A. The parts shown have maximum mechanical strength, lowest water absorption rate under immersion conditions and most stable dielectric loss properties. Fine for bushings and cores.



THIN-WALL SPIRAL TUBING has good concentricity and is tough. Note thin wall construction, cleanness of machining, variety of shapes. C-D-F Spiral Tubing is easily machined, formed, punched. Made in many grades for special applications.



NEW CONSTANT TORQUE TUBING, for permeability tuning with iron cores, features exact internal threading with three point suspension of the core to prevent binding . . . *no* external embossing to lower dielectric strength. Write for samples.



HARD OR SOFT, square or rectangular coil-form tubing is made for solenoid and transformer applications. Sides are straight with minimum gap in paper winding. Supplied in soft, varnished kraft, or hard, rigid tubing.

HF
HIGH FREQUENCIES
*radio interference and field intensity**
MEASURING EQUIPMENT

Stoddart NM-20B
150kc to 25mc
Commercial Equivalent of AN/PRM-1A

WIDE FREQUENCY RANGE . . . Covering the most widely used portion of the radio-frequency spectrum, the NM-20B is a precision instrument designed for field or laboratory measurement, analysis and interpretation of all types of radiated and conducted radio-frequency signals and interference. Sturdy dependability, broad frequency range and a full complement of accessories fit this instrument's outstanding characteristics to an impressive variety of applications. Includes standard broadcast band, radio range, WWV, ship-to-shore, amateur and other communication frequencies.

SELF-CONTAINED BATTERIES . . . Battery power allows portable operation of the NM-20B. The ac power supply permits operation from 105 to 125 volts or 210 to 250 volts ac at any frequency between 50 cps and 1600 cps. Its versatile power requirements and special weather-proof construction provide unlimited field operation.

PICKUP DEVICES . . . Pickup devices available for use with the NM-20B include the loop and loop probe, rod antennas and matching impedances for conductive inputs. These permit unlimited usefulness in measuring both conducted and radiated interference.

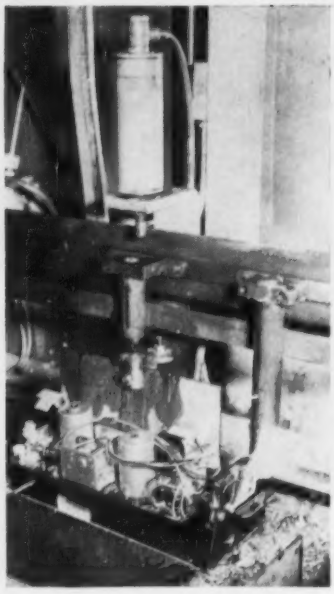
Stoddart Ri-Fi* meters cover the frequency range 14kc to 1000 mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-68. Very low frequencies.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.

UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17 Frequency range includes Citizen's band and UHF color TV band.

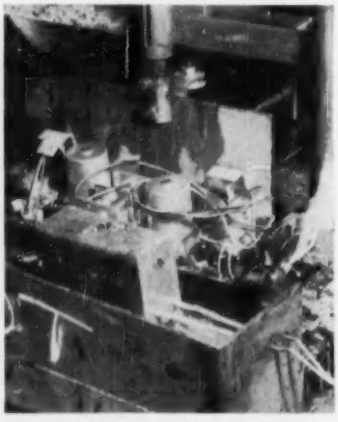
STODDART aircraft radio co., inc.
6644-A SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA HOLLYWOOD 4-9294



Spray fluxing station. Board is pushed down into baffles by air cylinder to minimize escape of spray during fluxing. Teflon wiper blade, mounted on conveyor chain ahead of wiring board bracket, wipes dross off solder pot at next station

to rest after an advance, the air cylinders are actuated to push the pallets down at their respective stations. The rod on the air cylinder comes down through a hole in the bracket on the chain to push down a spring-loaded inner shaft on which the pallet bracket is hung. The spring brings the chassis up again after the air cylinder has retracted entirely out of the bracket.

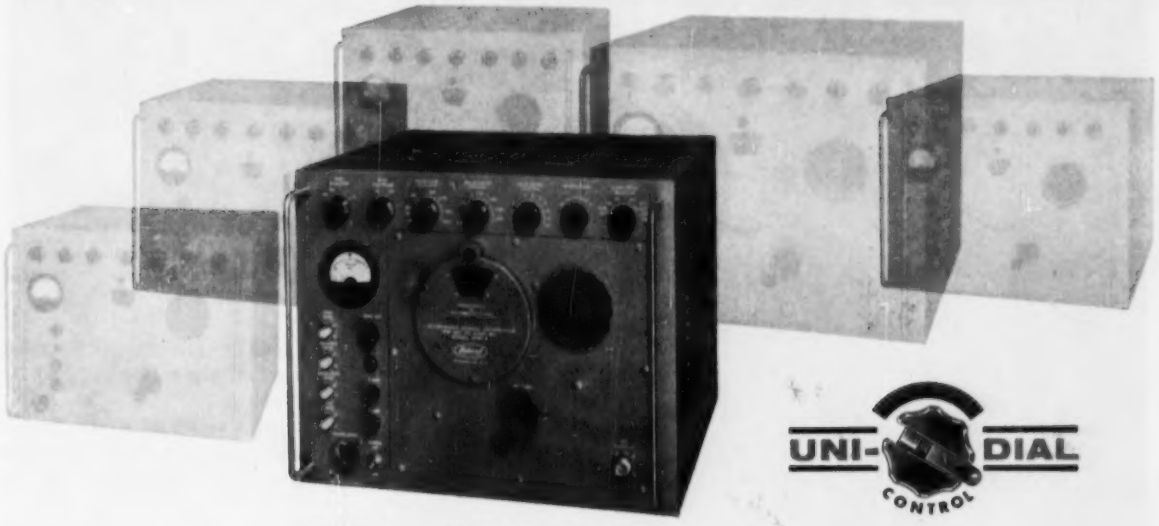
A hinged wiper blade is attached to a long rod bolted to the chain



Radio wiring board, hooked over conveyor bracket, is here in position over solder pot

MICROWAVE SIGNAL GENERATORS

950 to 11,500 mc



UNI-DIAL CONTROL

JUST ONE POLARAD MICROWAVE SIGNAL GENERATOR CAN MAKE ALL THESE MEASUREMENTS

- Receiver sensitivity
- Noise figure
- Signal to noise ratio
- Image rejection
- Beacon sensitivity
- Bandwidth
- Standing wave ratio
- Antenna gain and pattern
- Conversion gain or loss
- Attenuation
- Filter characteristics
- Multi-pulsed systems, such as Beacons, DME, Tacan, etc.

Each Polarad Microwave Signal Generator (4 models cover 950-11,500 mc) is equipped with the unusually simple UNI-DIAL control that tracks reflector voltages automatically while tuning continuously. Frequency, accurate to ±1%, is read directly on the single frequency dial. There are no mode charts, no slide rule interpolations necessary.

But, most significant are the **built-in** features that enable use of these rugged instruments for so many applications: internal modulation, pulse and FM; internal square wave modulation; synchronization outputs, delayed and undelayed; provision for multi-pulse modulation input; provision for external modulation and synchronization; variable attenuator calibrated directly in -dbm; engineered ventilation to insure specification performance over long operating periods.

Contact your local Polarad representative or write directly to the factory for the latest detailed specifications.

SPECIFICATIONS (all models unless indicated)

Model #	Frequency Range
MSG-1	950 - 2400 mc
MSG-2	2150 - 4600 mc
MSG-3	4450 - 8000 mc
MSG-4	6950 - 10,800 mc
MSG-4A	6950 - 11,500 mc

Frequency accuracy: ±1%

Power output:
MSG-1 & 2: 1 mw
MSG-3, 4 & 4A: 0.2 mw

Attenuator range: 120 db

Attenuator Accuracy: ± 2 db

Output impedance: 50 ohms nominal

Internal pulse modulation:
Pulse width: 0.5 to 10 microseconds
Delay: 3 to 300 microseconds
Rate: 40 to 4000 pps
Synchronization: internal or external, sine wave or pulse

Internal FM:
Type: Linear sawtooth
Rate: 40 to 4000 cps
Synchronization: Internal or external, sine wave or pulse
Frequency deviation:
MSG-1 & 2: ±2.5 mcs
MSG-3, 4 & 4A: ±6 mcs

Internal square wave modulation:
40 to 4000 pps

External pulse modulation:
Polarity: Positive or negative
Rate: 40 to 4000 pps
Pulse width: 0.5 to 2500 microseconds
Pulse separation (for multiple pulses): 1 to 2500 microseconds

Output synchronizing pulses:
Polarity: Positive, delayed & undelayed
Rate: 40 to 4000 pps
Voltage: Greater than 25 volts
Rise time: Less than 1 microsecond

Price:
MSG-1, 2 ..... $1,720.00
MSG-3, 4 ..... $2,190.00
MSG-4A $2,450.00

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

Prices subject to change without notice.

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Chicago • Dayton • Englewood • Fort Worth • Los Angeles • New York Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto- Export: Rocke International Corporation

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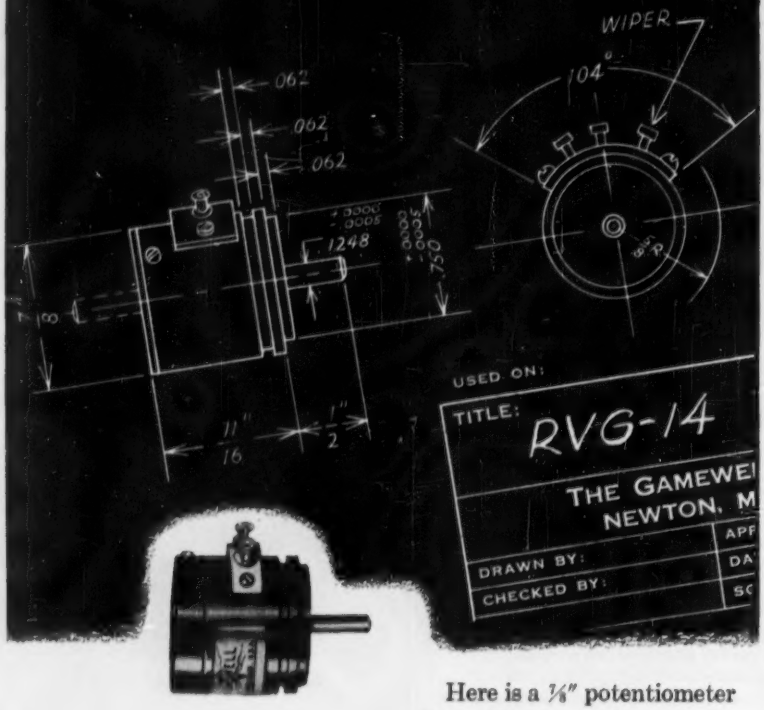
New 7/8" Precision Potentiometer by GAMEWELL



Here is a 7/8" potentiometer that offers you the extreme precision found in larger sizes of Gamewell Potentiometers.

Body is of anodized aluminum and the shaft is made of stainless steel. Kohlrausch type winding provides excellent linearity and the unit meets MIL-E 5400 specifications as they apply.

The unit can be modified for special mounting. Write for additional information about the new 7/8" type RVG-14 precision potentiometer.

THE GAMEWELL COMPANY
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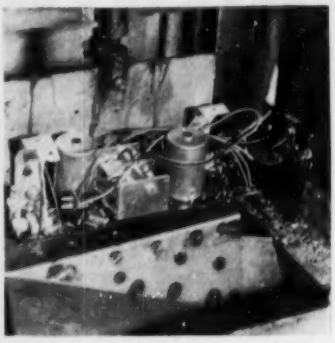
Torque, max. (ounce-inches)	0.25
Weight (ounces)	3/4"
Max. Resistance (ohms) ±5%	45,000
Min. Resistance (ohms) ±5%	25
Useful Angle (deg.)	354°
Min. Resolution (%)	0.06
Linearity (%)	±0.5

Multiple sections can be ganged; add 1/2" to overall length for each additional section. Better linearities can be obtained on special order.



Unloading station. Air cylinder is provided here for use if cleaning is needed after soldering

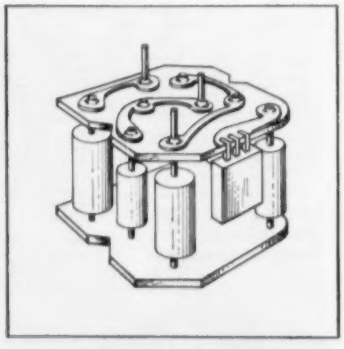
just ahead of each bracket, to sweep the dross off the solder pot just before dipping.

Silicone rubber caps are pushed over the shafts of the volume control and band-changing switch before dip soldering, to give automatic masking. The caps are gripped by the threads of the controls, and are easily removed afterward.

Modular Bundles Use Etched-Wiring Boards

By ROBERT J. ROMAN
Eastman Kodak Co.
Rochester, N. Y.

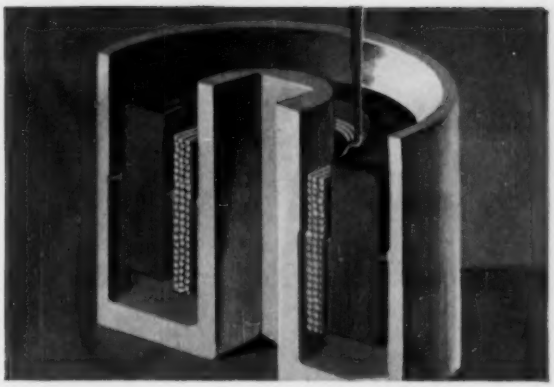
LOW-VOLUME users of printed circuits look to mechanization for versatility and low tool cost, to permit frequent changes in the product without excessive change-over costs. This is very difficult to accomplish with machines alone. Great simplification of the problem has been achieved by stand-



Example of Paraplate bundle, showing how some leads can be left long after soldering, for use as interconnecting terminals. Multiple-lead couplates can be soldered into notches on edge of one plate, as on upper plate here

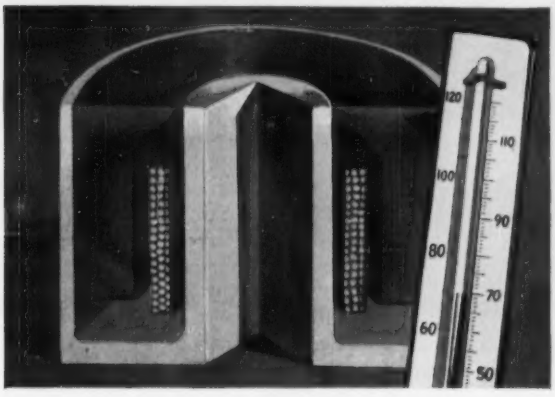
POURED AS A LIQUID

BAKELITE Epoxy Resin, mixed with hardener, is poured into place, without harm to fragile elements in the assembly. The mixture will cure with excellent adhesion to metal, ceramics or glass, bonding them firmly in position.



FILLS EVERY CREVICE

Low viscosity permits BAKELITE Epoxy Resin—hardener combination to penetrate extremely minute cavities. Air entrapment is minimized. Vibration or centrifugal casting reduces it further, aids in filling, and eliminates bubbles.



HARDENS WITHOUT HEAT

BAKELITE Epoxy Resins can cure at room temperature—another advantage where parts would be damaged by high temperatures needed to set other potting materials. Oven curing at low temperatures may be used for more complete reaction.

KEEPS ASSEMBLY SAFE

Cured BAKELITE Epoxy Resin resists shocks, chemicals, moisture. It keeps the assembly solidly embedded, safe from external hazards. Resin shrinkage is so slight as to be unimportant for most applications, but can be further reduced by use of fillers.

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Many electrical assemblies seem to grow more fragile as they become more efficient. But BAKELITE Brand Epoxy Resins are making them more serviceable than ever. Three different types of these resins are available for potting and encapsulating techniques. They can be cured by any of four specially formulated BAKELITE Epoxy hardeners designed to give a variety of viscosities and curing speeds, or by several conventional catalysts. We can help you pick the combination with the best set of properties for your product. In addition, there are BAKELITE Phenolic and Polyester Resins ideally suited to give you the widest selection of materials available. Find out what all these resins can do. Write Dept. BL-50.

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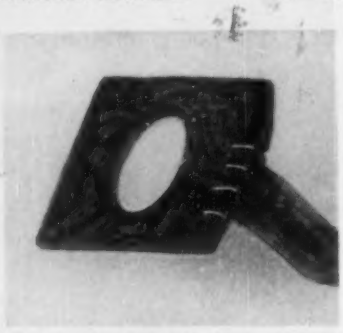
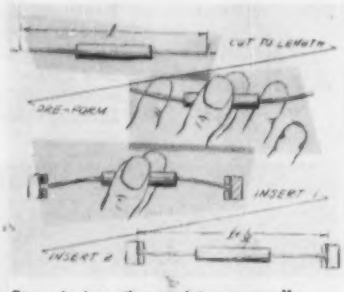


Method of soldering leads of subminiature tube to edge notches of board



Steps in inserting resistor manually

ardizing on a basic module for axial-lead components, called a Paraplate bundle. Here the components are installed between two parallel etched-wiring boards and the connections are dip-soldered in two operations.

Nonaxial-lead components, such as tubes, transistors and switches, can be added at any time by using slot-soldering terminations around the edges of the boards. A slotted termination is ideal for this application as it will not close up or bridge when dip-soldered without a wire inserted.

► **Advantages**—When properly supported, modules of this type satisfy varied environmental requirements at least as well as the average components they support. For most component groupings, the bundle requires less total etched-wiring-board area than most flat mounts.

Space characteristics are exceptionally good for most component groupings. The two-plate construction allows for crossovers without expensive, troublesome double-sided prints. Exclusive of any mounting structures which may be required, the bundles are self-supporting.

An improved new assembly method for the modular system

Whiskers on tin-plated steel, enlarged 6 times. Immense yield strength of metals in whisker form was discovered by Bell scientists.

The clue of the metal whiskers

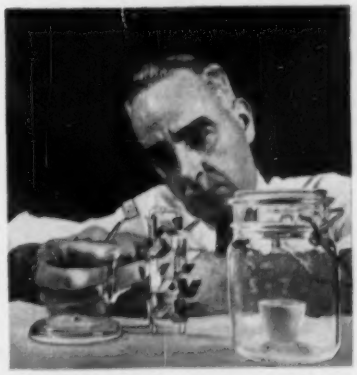
The habit of close observation at Bell Laboratories often turns "tremendous trifles" into important scientific progress. Such a case occurred when unexplained short circuits in wave filters seemed to be associated with a zinc-plated mounting bracket.

Close scrutiny disclosed a whiskery growth on the zinc plating. Similar whiskers of tin were found growing on tin-plated equipment. Studies showed the whiskers to be tiny single crystals of metal.

Suspecting that these unusual crystals might be of essentially perfect structure, alert Laboratories scientists saw an opportunity at last to test an important metallurgical theory.

The scientists studied the whiskers, grew larger ones, and showed that the crystals had enormously high yield strength as predicted by the theory for perfect crystals—a strength far greater than for the same metal in any other known form. This clue has opened new frontiers in the study of what makes metals strong or weak, and has excited metallurgists all over the world.

Thus, another new advance has come out of the Bell Telephone Laboratories practice of scrutinizing *everything* that can play a part in better telephone service.



Through the study of thousands of specially cultivated whiskers, Bell scientists seek to prevent treacherous growths in telephone equipment.

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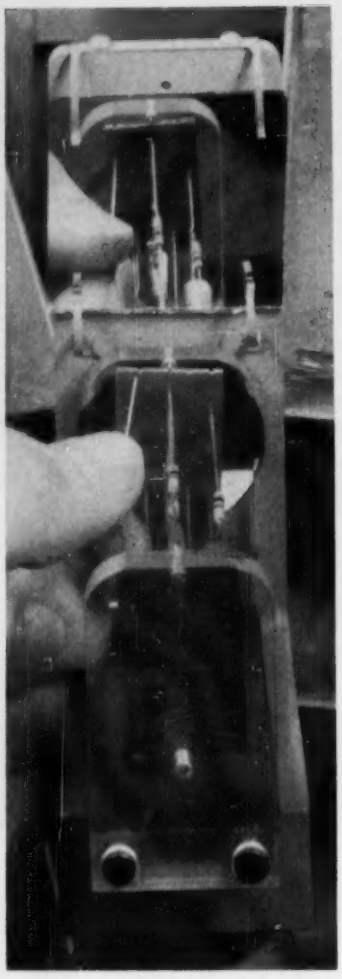

Method of inserting component by hand. Mirror at rear aids operator in putting lead into board closest to her

features ready adaptability to high or low production with negligible tool and equipment cost.

With the two $\frac{1}{16}$-inch-thick etched wiring boards held against back-up plates at some distance $L - \frac{1}{32}$ inch, where L is the cut length of all components, the component is inserted in four steps: (1) precut to length L; (2) preform slightly to decrease overall length approximately $\frac{1}{32}$ inch; (3) insert first component lead; (4) insert second component lead; (5) straighten leads.

▶ **Manual Assembly Fixture**—The U-shaped assembly cradle has a steel base with clear plastic back-up plates affixed to each end. As the printed circuit plates do not have to be accurately located, they are

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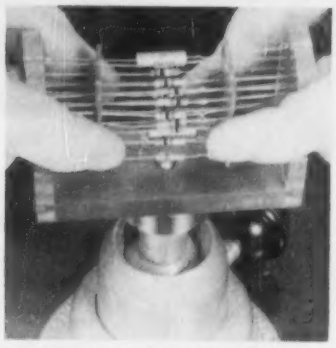
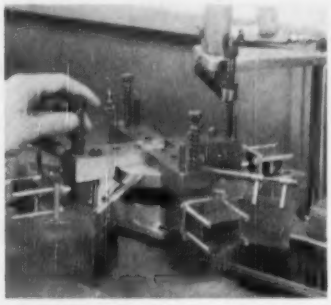
Work setup of manual assembly, using bench fixture to hold wiring boards



Pushing wiring boards together after inserting all components



Setup used for fluxing and dip soldering after loading boards manually

affixed to the back-up plates with simple spring clips. Each station has a universal holding fixture with an inset Alnico magnet for firmly gripping the cradle. An adjustable mirror on the holding fixture allows the operator to see both plates at once. Depending on the volume and complication of the bundle being run, two or more work stations can be lined up, with bundle cradles passing from one to the other.

When all components have been assembled, an operator removes the bundle from its cradle after first pushing the wiring boards together

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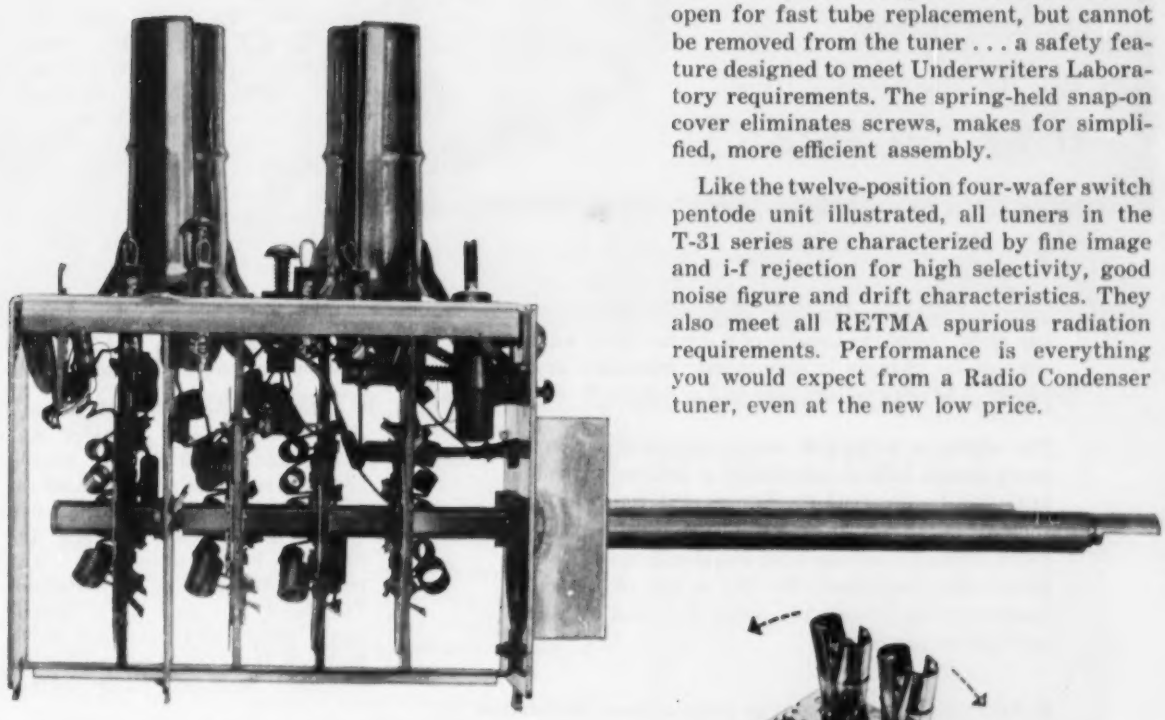

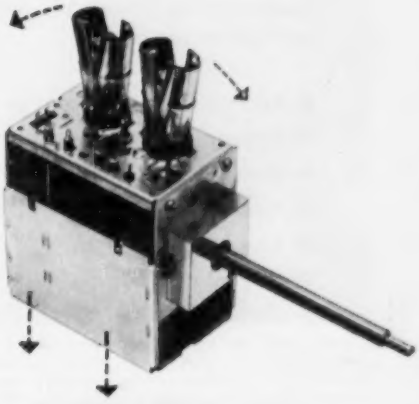

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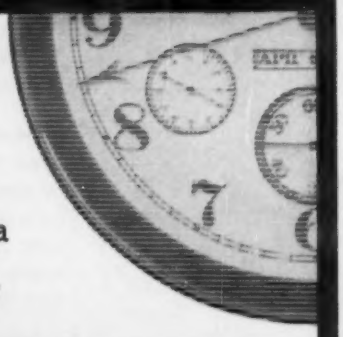

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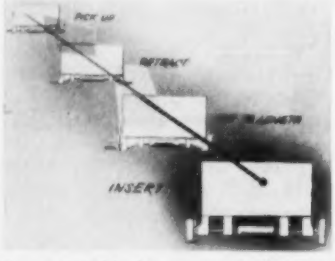
to the final bundle distance. The bundles are then inserted in the holders of a dipping machine, where all joints are dip-soldered automatically.

▶ **Automatic Insertion Head**—The basic principle of the retraction insertion head developed for mechanized assembly is not altogether different from the manual method. The component is first picked up by a four-jaw head. The two inner jaws lock against the wire when closed, but the two outer or metering jaws permit the wire to slip when closed. When the inner jaws retract in the second step, about $\frac{1}{8}$ inch of wire is pulled through each metering jaw and stored in the loop. After the excess wire is cut off in the third step the head has both wires in excellent length and coordinate control. The head is then placed in position between two etched-wiring boards and the inner jaws are returned to their original position to complete the insertion.

▶ **Automatic Assembly Machine**—A proposed in-line transfer machine has etched-wiring boards carried from station to station on platens or cradles in a manner similar to the hand method. Insertion head assemblies are mounted in pairs at each station. The head will pick up a component, retract and cut, then move between the circuit plates for an insertion. Horizontal and vertical



Steps in achieving automatic insertion

Basic tool used for automatic insertion

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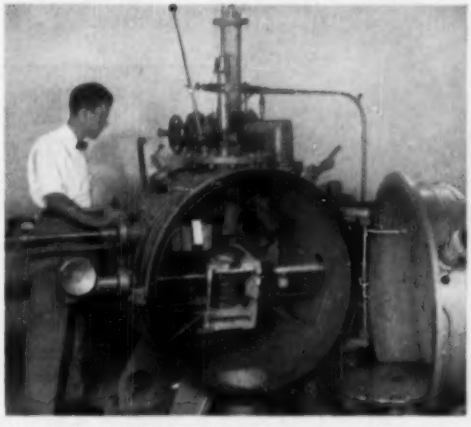

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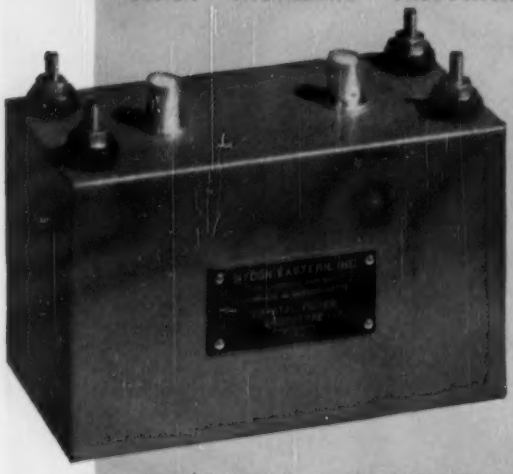

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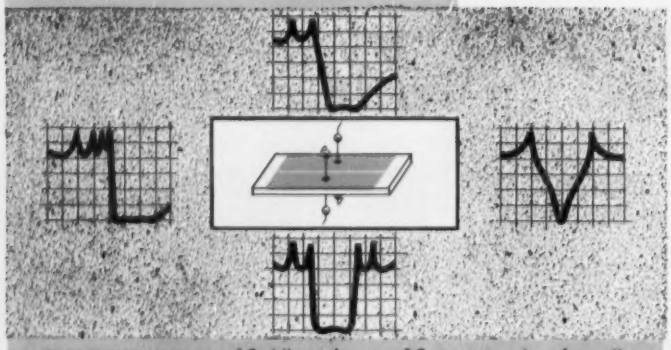

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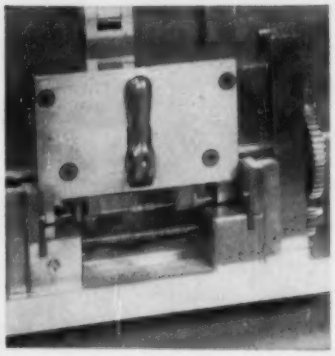


Inserting head, shown just as it is putting resistor into holes of etched wiring boards held on positioning pegs in fixture

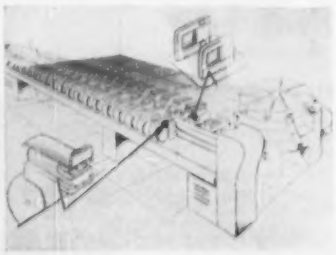
position adjustments are made independent of head motion. Since the head will accommodate a wide range of components, accurate direct-reading adjustment devices can be employed to minimize changeover time.

Etched wiring boards are fed in at one end of the machine and completely assembled bundles removed from the other. Although the machine is planned for magazine-type board feed and an automatic-bundle-transfer head, the feed and removal can be accomplished in any way consistent with the size of the run.

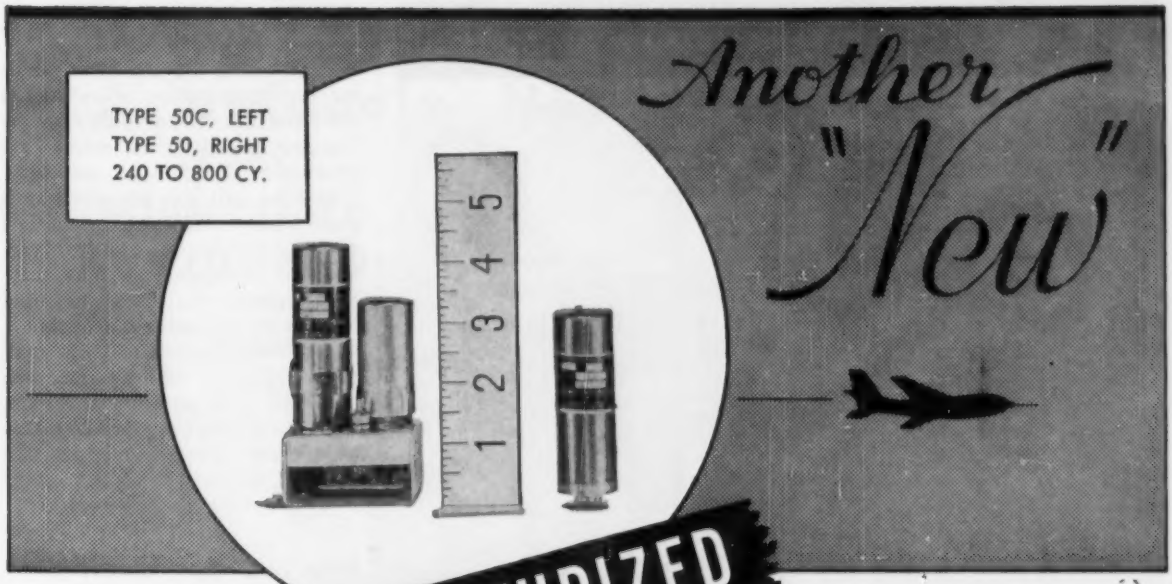
Here, as with the hand method, bundles are transferred to another machine for dip soldering.

▶ **Automatic Soldering Machine**—The transfer head at the output of the assembly machine would be equipped with cutter plates which cut excess wires during the transfer cycle. The bundle is transferred to a relatively simple holder on the dipping machine.

The soldering machine is basically an indexing-turret type with



Sketch of automatic assembly and soldering setup planned for use with Paraplate bundles



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Introduced here are miniature versions of our popular Type 2003. They have equivalent accuracy but are much smaller, lighter and have fewer component parts. In the Type 50, all critical components are housed within the fork container.

Both the Types 50 and 50C offer superior shock resistance, up to 60 G. Hermetically sealed and shielded.

When requesting information, please state type number.

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FREQUENCY STANDARDS ■ AND PRECISION FORKS

PICTURED AT LEFT, ABOVE

TYPE 50C SPECIFICATIONS

SIZE....2¼" x 2" x 4⅜" high. WEIGHT....8 ozs.
ACCURACY.....±.02% from —65° to 85°C
OUTPUT.....5V into 250,000 ohms
TYPE R50C.....Same as Type 50C with accuracy of ±.002% from 15° to 35°C

PICTURED AT RIGHT, ABOVE

TYPE 50 SPECIFICATIONS

SIZE....1" dia. x 3¾" high. WEIGHT....3.5 ozs.
ACCURACY.....±.02% from —65° to 85°C
OUTPUT.....5V into 250,000 ohms
TYPE R50.....Same as Type 50 with accuracy of ±.002% from 15° to 35°C

For 17 years this company has produced precision frequency standards for integration in highly accurate instruments and timing devices of our own and other manufacture. We make frequency standards within a range of 30 to 30,000 cycles, a field in which we offer maximum accuracy, simplicity and durability. Our products are now serving in many and varied applications—in industry, government (including the armed services, particularly in the field of aviation) and for laboratory uses.

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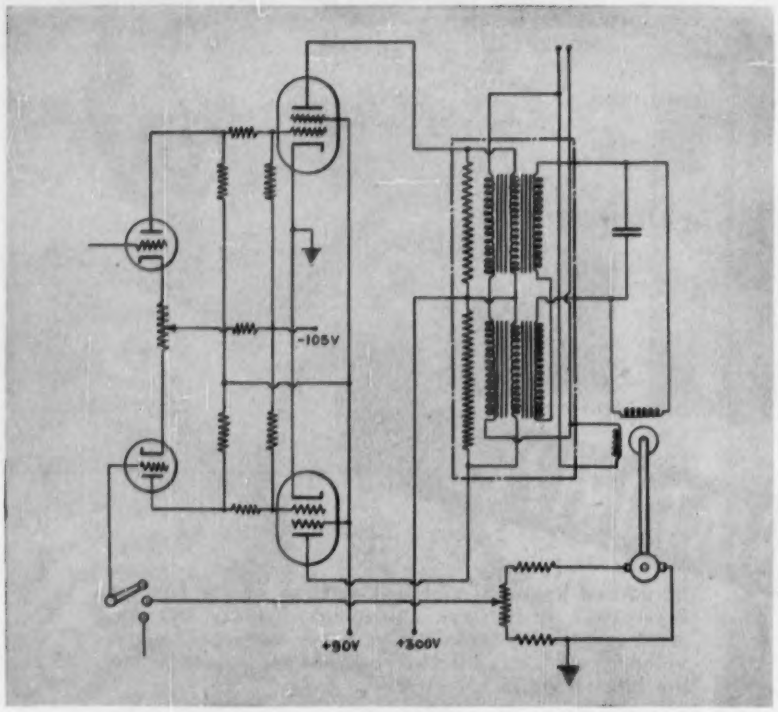

Servo Motor Control System

Most engineering ingenuity concentrates not on basic principles, which are relatively simple, but on the fine details that make the difference between good and poor design, between high and low cost, or between efficient and inefficient component arrangement. For instance, the motor control system patented by the Ford Instrument Company. The purpose of the system is to provide a sensitive control system to make an induction motor respond accurately to a relatively small reversible input signal. This system employs saturable-core transformers to combine the sensitivity of vacuum tube amplifiers with the high power-carrying capacity of saturated-core devices. This also facilitates the problem of matching the motor impedance with that of the amplifier.

In the circuit shown the first pair of tubes act as a phase inverter, with the control signal applied to the grid of one inverter tube. The feedback signal, produced by a d-c generator coupled to the controlled motor, is applied to the inverter tube. The output of the inverter is the signal of the servo loop. The second pair of tubes acts as a driver-stage for the saturated transformers that supply one winding of the controlled two-phase induction motor; the other motor winding is connected to the power line.

This is typical of the things Ford engineers do . . . every day. If you have a control problem it will pay you to talk to the Ford Instrument engineers.

83

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DIVISION OF SPERRY RAND CORPORATION
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vertical-acting dipping arms, similar to the prototype operating on the hand line. The dipping machine features simplicity of action and peninsular location of solutions.

Making full use of advantages gained by modular restrictions and the reliable simplicity of retraction insertion, the inherently high-capacity multihead machine is easily adapted to economical low-volume operation. It is estimated that a 40-head machine equipped with suitable short-run component programming could be completely changed over in less than 15 minutes.

Dip-Soldering Clamp Masks Tube Socket

Immersing board in first soldering pot. Cake of beeswax in left hand will be wiped over next pot before transferring board to it

A SPRING-LOADED clamp assembly welded to the jaws of long-nosed pliers serves as a convenient tool for holding a small wiring board during dip soldering in RCA's Indianapolis plant. Squeezing the plier handles together opens the disk-shaped jaws of the clamp enough to permit placement over the tube socket. When the jaws are released, the entire tool serves as a handle for immersing the board in the pool of molten solder. The metal disks of the clamp prevent solder from getting into the tube socket contacts.

Two solder pots are used side by side. After immersing the board in the first one, the operator wipes a cake of beeswax over the surface of the second pot and immerses the board in this, to complete the

A uniquely NEW Oscillograph from Midwestern Instruments

Midwestern's New Model 590 incorporates every feature necessary for a successful flight-test instrument.

Specially designed for remote control*

**If desired the instrument can be supplied with no controls on it. All control then originates at a remote location.*

Here's another great development in Midwestern's series of famous flight-test instruments. It is based on extensive experience applying other Midwestern oscillographs to many combinations of environmental conditions. One of the many features is a remotely-controlled jump-speed system. Speed may be changed at any time by simply positioning a rotary switch to the required setting. 20 recording speeds are possible with this electrically-actuated system and change gears within the oscillograph. Lamp intensities are automatically adjusted to a previously-set value for recording at the new speed. The single aluminum alloy casting is ribbed for the strength and rigidity needed under high acceleration conditions.

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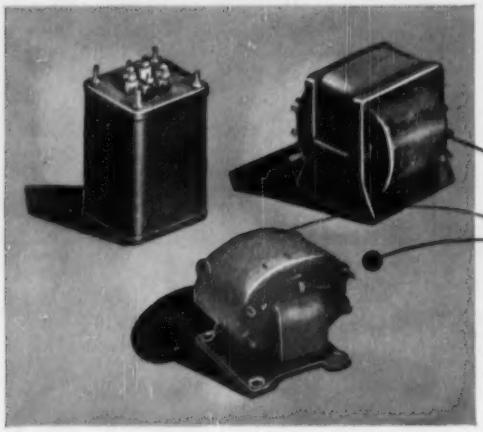
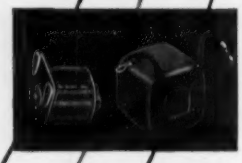
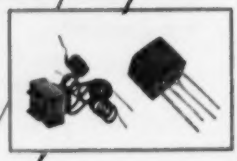


Every design engineer or production man we ever met makes mental notes of good places to get quick aid on needs out of the ordinary.

You might like to know, therefore, that a great deal of the work we do here at Wheeler on transformers, coils, harnesses, custom-built electronic assemblies, and communications components is just that kind of assignment.

We publish no catalog of the everyday standard items . . . they present no problem to anyone. We do serve an increasing group of engineering and production departments that require competent help . . . backed by ample manufacturing facilities . . . in producing components that are "a little (or a lot) different." Call or write us for an interesting story.





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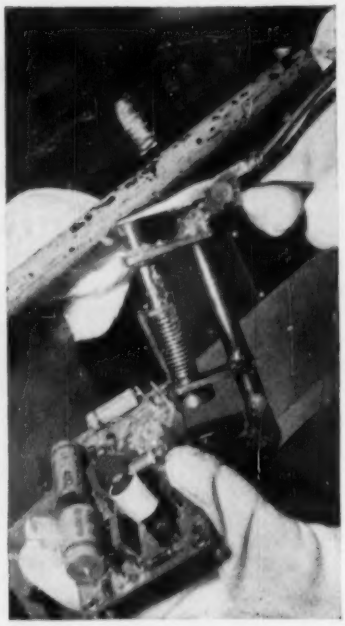
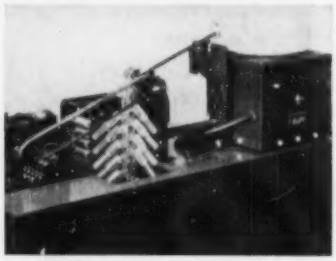


Method of placing clamp over socket of wiring board

buildup of solder over each of the clinched leads. The double-pot technique has greatly improved the reliability and uniformity of dip-soldered joints on etched wiring boards used in the firm's radio and television receivers.

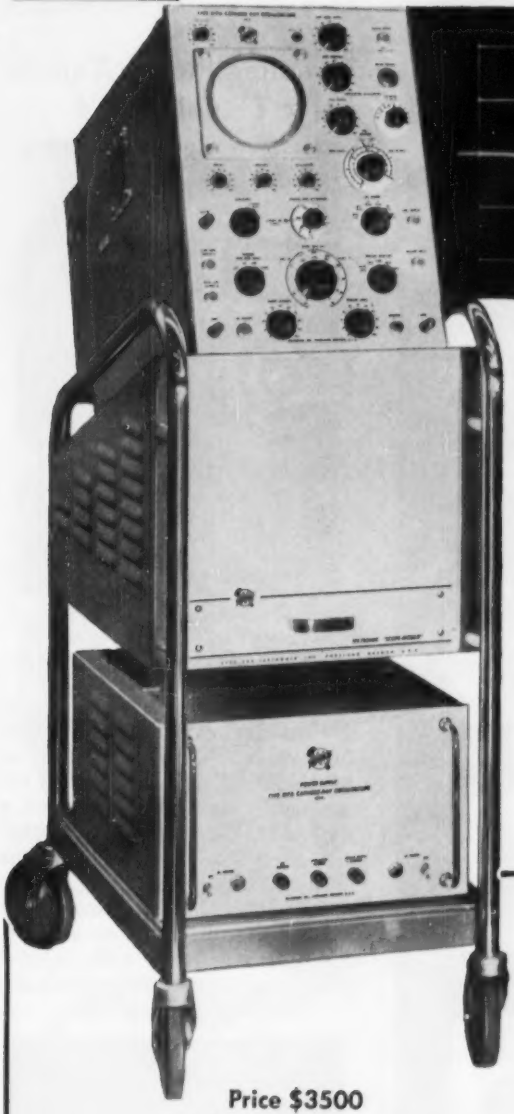
Automatic Tester for Ferrite Memory Cores

FERRITE storage cores are automatically tested and graded by International Telemeter Corp. of Los Angeles with a new machine incorporating a Syntron model EB-01-B vibrating parts feeder. The cores are placed in the feeder, which lines them up and delivers them down a chute to a mechanism that sorts into sixteen uniform



Core tester, with feeder at right, sorting mechanism at center and motor drive at left

1100-cm/μsec writing rate!



Arrow indicates 1100-cm/μsec writing-rate point on 100-mc damped oscillation, displayed on single 0.01 μsec/cm sweep of Type 517A Oscilloscope with T54P11H crt. Recorded on 35-mm TRI-X film at f 1.9 with 4.2 to 1 reduction, developed 26 minutes in D-19 at 68° F.

The Tektronix Type 517A Cathode-Ray Oscilloscope has the high writing rate, faithful transient response, fast sweeps, and dependable stability necessary for accurate analysis of single high-speed occurrences. Improvements in several performance areas, made possible by the development of a new Tektronix high-voltage cathode-ray tube, make the Type 517A even more useful than its famous predecessor, the Type 517. Sensitivity of the Type 517A is double that of the Type 517, both sweep and vertical linearity are improved, and the viewing area is increased to a full 4 cm by 8 cm. An automatic duty-cycle limiter prevents accidental damage to sweep-circuit components. The exceptional performance characteristics and accurate display of the Type 517A can speed up progress in work involving high-speed transients.

Price $3500

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Includes indicator unit, power-supply unit, scope-mobile, cathode-follower probe, 7-step attenuator unit, viewing hood, bezel, 170-ohm cable.

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Transient Response—Risetime seven millimicroseconds.
No overshoot or ringing.

Maximum Sensitivity—0.05 v/cm.

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from 0.01 μsec/cm to 20 μsec/cm. Each can be adjusted to the accuracy of an external standard.

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24 kv on T54P11H Tektronix metallized precision cathode-ray tube.

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Less than 1% of 8 cm horizontal, less than 2% of 2 cm vertical.

Rate Generator—
15 to 15,000 cycles, accurate within 5% of full scale.

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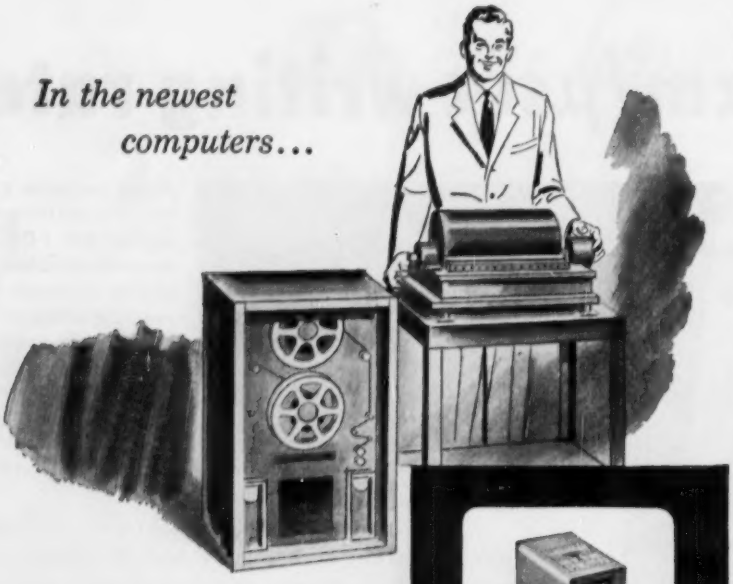

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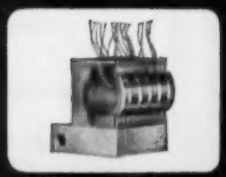
BK-1300 series—up to 25 interlaced channels per inch.

BK-1500 series—ultimate in precision-made multichannel heads.



BK-1605 series—simple mounting and adjustment, ideal for drum computers.

BK-1501 series—compact, wafer-thin, permit individual adjustment.

BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.

BRUSH ELECTRONICS COMPANY

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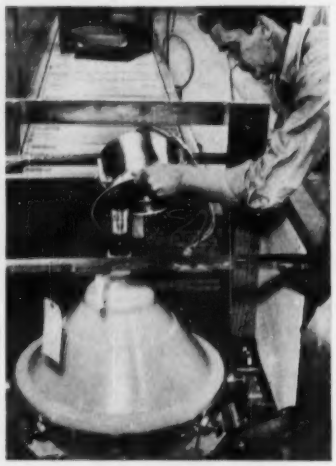
BRUSH ELECTRONICS

grades on the basis of magnetic properties. The tester is able to handle one core per second; in this time, as the core passes through the test contacts, 5,000 separate trials of each of two tests are made.

Mounting Picture Tube in Color TV Cabinet



Placing yoke assembly over neck of color picture tube. Tube rests on molded plastic ring which can be seen in cabinet at rear on conveyor

ON THE final cabinet assembly line for 26-tube color-tv consoles in RCA's Bloomington, Ind. plant, the cabinet is placed face down on a wood slat conveyor. This position simplifies the installation of the molded plastic support ring for the picture tube, which is fastened with wood screws driven by an air gun. The picture tube, with molded plastic jacket over its metal wall and

Using special cam-action ratchet wrench to tighten knurled nut on one of three tie rods that hold picture tube assembly against front of cabinet

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Outstanding for many years as the Top Performer, Clevelite is unmatched in its ability to meet unusual specifications.

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Available in diameters, wall thicknesses and lengths as desired, for Collars, Bushings, Spacers, Cores and Coil Forms.

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Our improved Torkrite internally threaded and embossed tubing affords better control of adjustments in coil forms using threaded cores.

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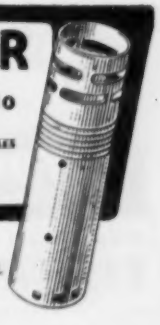

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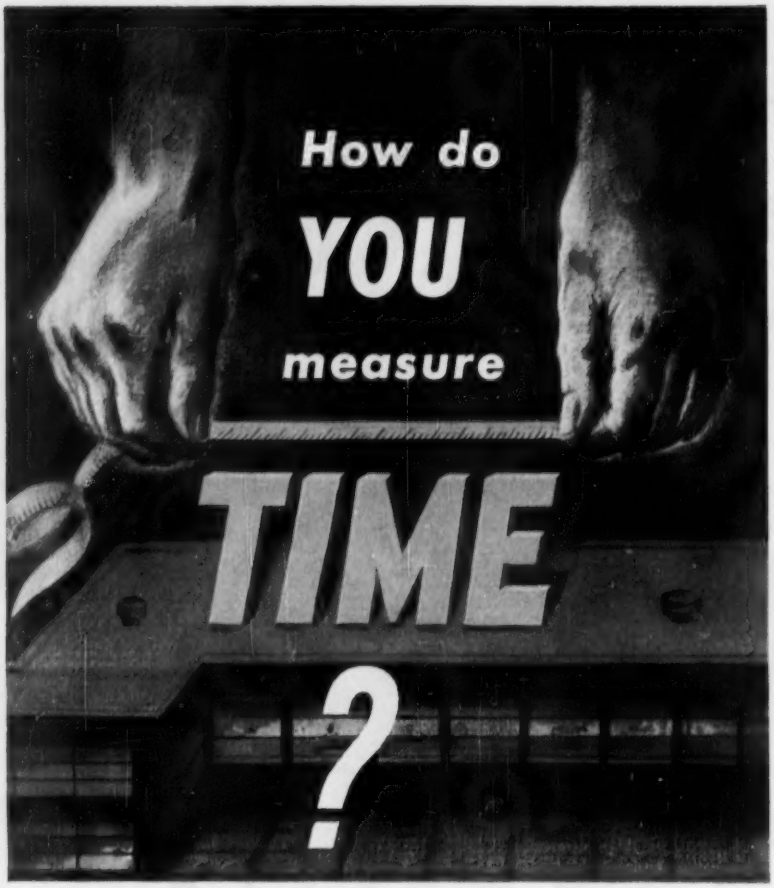

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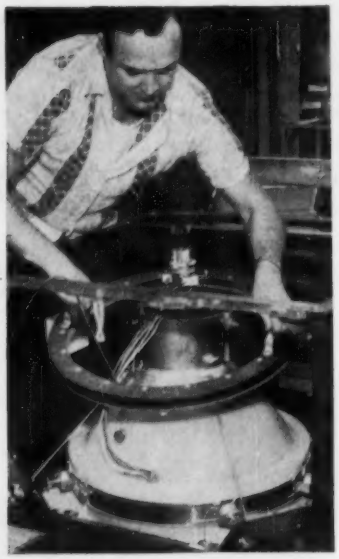

Method of degaussing yoke assembly. Earth's-field compensating magnets can be seen on band surrounding rim of picture tube. Yoke tie-rods go to metal inserts in wood corner brackets

with the earth's-field compensating magnets mounted around its rim, is then lowered into position on the plastic ring.

The yoke assembly is brought down over the neck of the picture tube, and three steel tie rods are run from the cabinet to the frame of the yoke to hold the entire picture tube assembly in position. A special ratchet wrench is used to tighten the knurled nut that goes

New 26-tube color-tv consoles on wood shipping pallets ride down slat conveyor at lower level and are pushed up over rollers on incline to start of next slat conveyor at higher level, for passage through screened and partially darkened final test rooms

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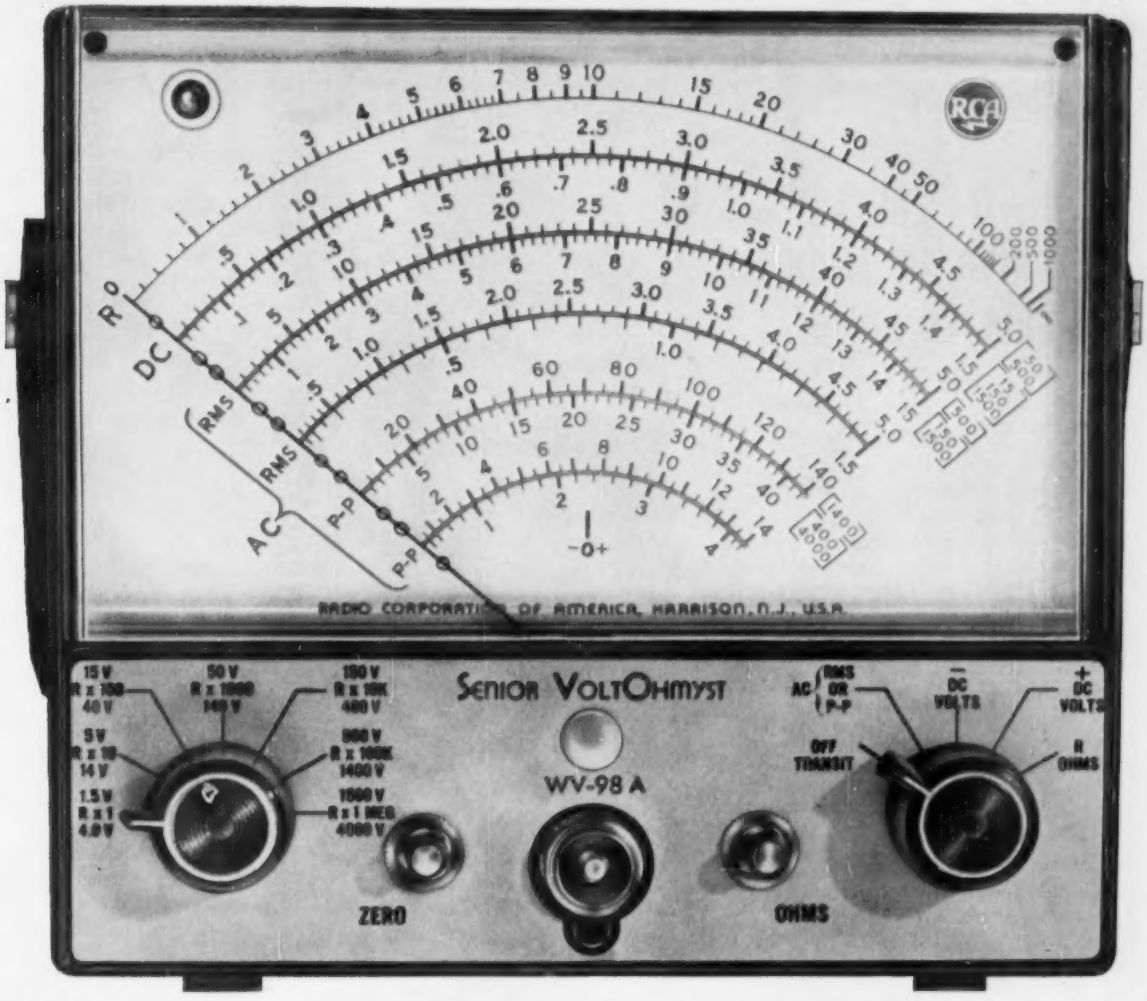

Senior VoltOhmyst, RCA WV-98A, only $75.00 User Price* including probe and cable, instruction booklet, complete and ready-to-use . . . Shown slightly smaller than actual size.

*Optional

new!

You can work faster, more accurately—when you own and use the new RCA WV-98A SENIOR VOLTOHMYST with the extra-large full-vision meter-face. "Speed-up" in your service work—without the slightest sacrifice in quality—means a "build-up" in your profits. Look at the easy-to-read expanded scales. Then look at some of the other advanced features you also get.

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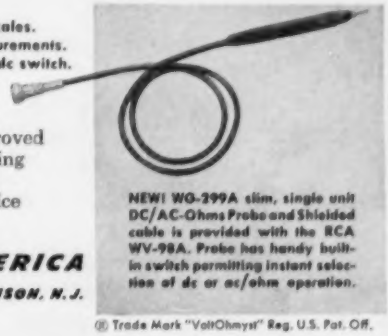
- **Expanded meter scales . . . separate peak-to-peak voltage scales.**
- **Accuracy of 3% full-scale on *BOTH* ac and dc voltage measurements.**
- **Sturdy, single-unit streamlined probe with built-in ac-ohms/dc switch.**
- **Rugged die-cast aluminum case.**
- **Compact design: 7" wide, 3¾" deep, 6½" high, 6 lbs.**

The all-new WV-98A has all the important, time-proved performance features of earlier VoltOhmysts including direct reading of peak-to-peak voltages of complex waveforms. See this highly accurate, versatile, service instrument at your RCA Distributor! Order now.



NEW! WO-299A slim, single unit DC/AC-Ohms Probe and Shielded cable is provided with the RCA WV-98A. Probe has handy built-in switch permitting instant selection of dc or ac/ohm operation.

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over the threaded end of each tie rod.

The final step is degaussing the yoke structure. This is done by lowering over the neck of the picture tube a large coil connected to the 115-volt a-c line, leaving it there about 10 seconds, then slowly lifting up the coil.

After mounting the picture tube, the cabinet is turned upright and assembly is completed at subsequent positions on the conveyor. The back cover and the removable top of the cabinet are put on last. The top is made removable so that servicemen can reach in from above to adjust the earth's-field compensating magnets around the rim of the picture tube.

Substitutes for Eyelets in Etched Wiring

By L. J. MARTIN and M. J. VAVRA
Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.

OPEN circuits and poor joints are a major threat to etched circuit reliability. Open circuits are most apt to occur in the vicinity of connections to component leads, either through failure of soldered connections or through breakage of the etched conductors. Bond strength between the conductor and laminate is limited and may be impaired if a connection is overheated by hand-soldering, as in replacing components. These conductors are unable to withstand heavy stresses applied by component leads if these stresses tend to pull the conductor away from the laminate or even to rotate or shear the bond. They are, however, amply immune to stresses directed toward the laminate. This is illustrated in Fig. 1.

Connections should be protected

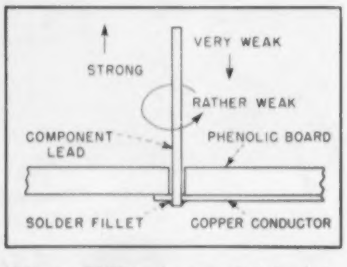

FIG. 1—Ability of conventional lead to withstand stresses in various directions when soldered to etched wiring board

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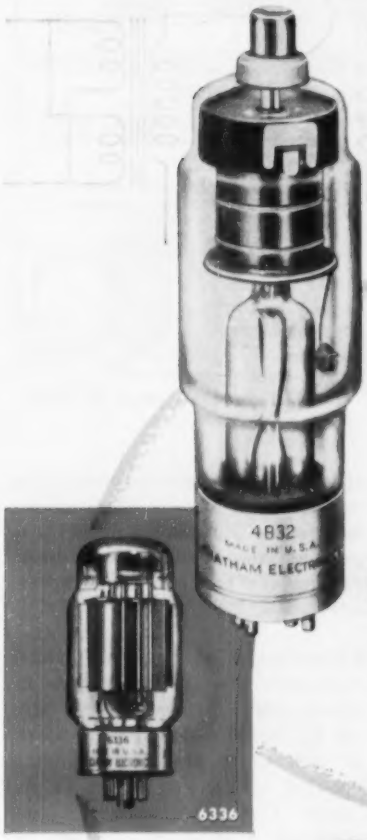

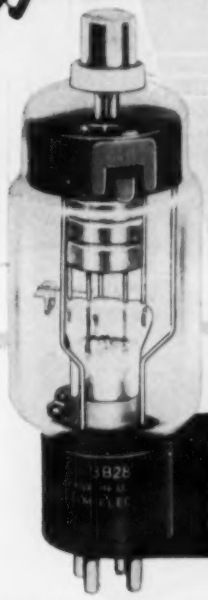

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Rugged half-wave Xenon filled rectifier. Operates in any position. Ambient temperature range −75° to +90°C. Inverse peak anode voltage 10,000, average current .25 amps. Filament 2.5v., 5 amp.

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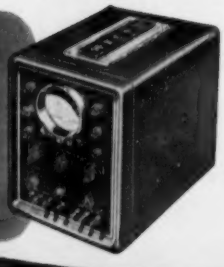

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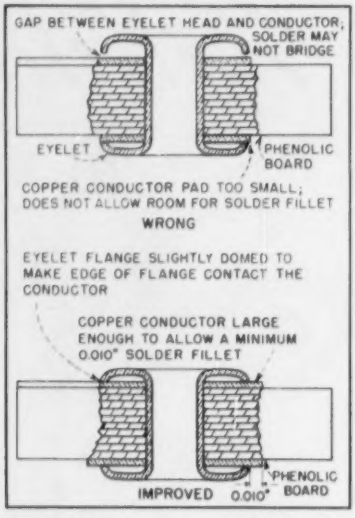
GAP BETWEEN EYELET HEAD AND CONDUCTOR; SOLDER MAY NOT BRIDGE
EYELET
PHENOLIC BOARD
COPPER CONDUCTOR PAD TOO SMALL; DOES NOT ALLOW ROOM FOR SOLDER FILLET
WRONG
EYELET FLANGE SLIGHTLY DOMED TO MAKE EDGE OF FLANGE CONTACT THE CONDUCTOR
COPPER CONDUCTOR LARGE ENOUGH TO ALLOW A MINIMUM 0.010" SOLDER FILLET
IMPROVED
0.010"
PHENOLIC BOARD

FIG. 2—Forming of eyelets on etched wiring

from those stresses to which they are weak, either by forming the leads and placing the components to prevent these stresses or by reenforcing the connections with eyelets.

▶ **Drawbacks of Eyelets**—Eyelets frequently are used to provide interconnection between etched wiring on opposite sides of the board, as well as to provide mechanical bonding of the conductors to the board. This use of eyelets allows repeated change of components without danger of lifting the conductors from the base material. These eyelets, however, form additional links in the wiring and unless properly used may be a source of unreliability. Gold-plated or solder-plated eyelets wet readily when solder-dipped, this being essential for obtaining reliable joints. After plating, the eyelets should be cleaned, dipped in stearic acid flux and baked dry.

Installation of eyelets is accomplished by applying controlled pressure to a pair of eyelet-heading dies. The shape of the forming cavity of the die is important. Improper forming of the eyelet heads may cause poor solder joints, as illustrated in Fig. 2. Improper eyeletting can, and has, caused unreliability of the most troublesome kind because, when corrosive flux residues become trapped under their heads, failures may develop

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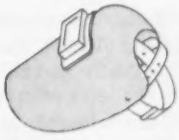

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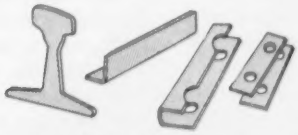

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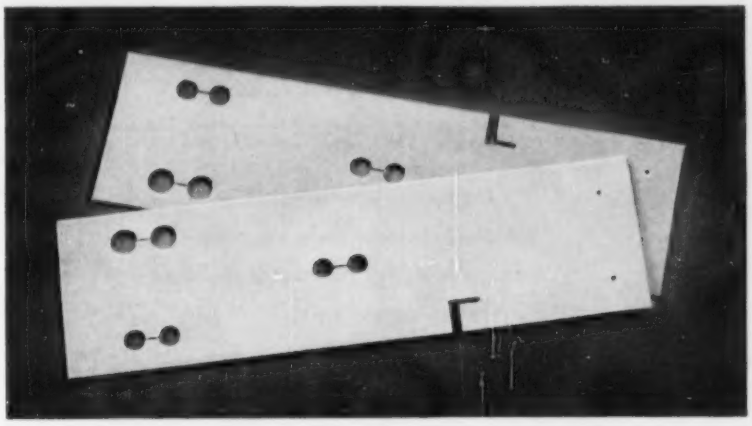

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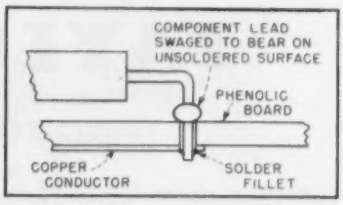

FIG. 3—Method of swaging component lead to obtain greater mechanical strength in etched wiring assembly

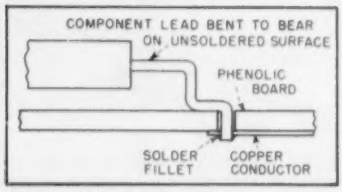

FIG. 4—Method of forming component lead to obtain greater strength

later. Not only are proper forming and soldering difficult, but the labor required is costly and this destroys much of the economic attractiveness of dip-soldered etched circuitry. Consequently, there is a trend toward eyelet elimination.

▶**Eyelet-Eliminating Techniques**—If wiring boards are to be produced without eyelets, provision must be made to insure that the stresses applied to the leads of components cannot be transmitted to the conductor on the board in such a manner as to tear it away from the base material or fracture it. This can be done by swaging the component lead on the unsoldered side, as shown in Fig. 3. Another method is to form the lead in such a manner that it bears against the unsoldered surface for a short distance before it enters the hole (Fig. 4). Still another way is to arrange the components for edge-dipping as in Fig. 5. This provides

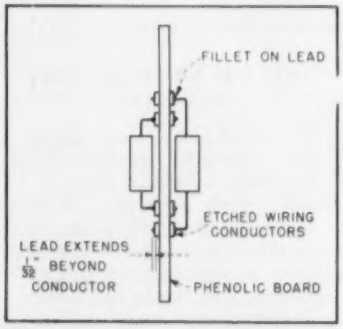

FIG. 5—Arrangement of components for edge dip soldering, to obtain strong fillets on both sides of board

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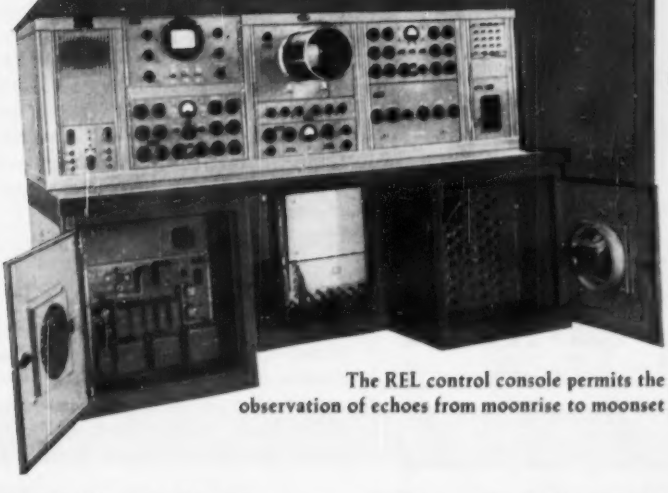

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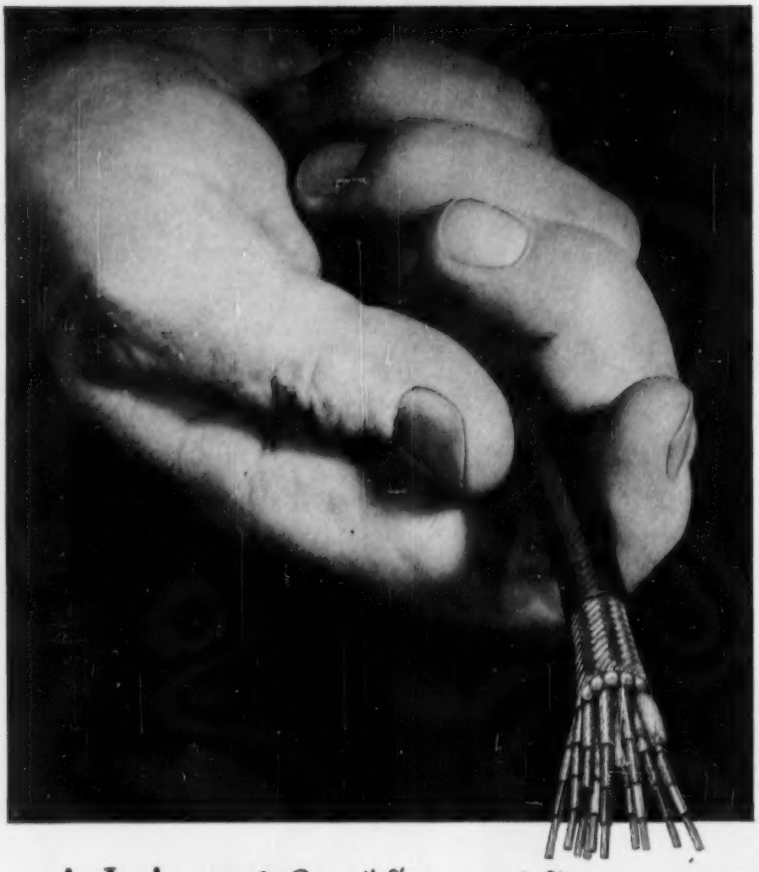

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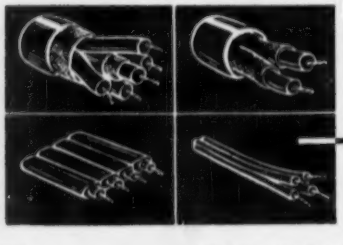

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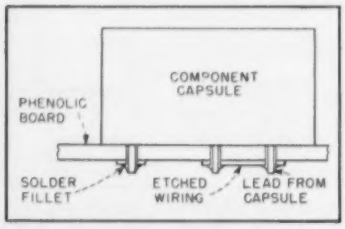

FIG. 6—Mounting component flat on board gives greater strength

a fillet of solder around the lead on both sides of the board, preventing the stripping of conductors from the board by a force exerted on the lead from the component side of the board. Eyelets also can be eliminated when leads emerge from the bottom of a component capsule, as in Fig. 6.

► **Coatings for Wiring Boards**—After the etched circuit assembly has been completed, it often is desirable to coat the board to control subsequent surface contamination. The requirements of a good protective coating are: high humidity resistance consistent with good recovery properties; adequate electrical properties; cure at 75C or less so that the coatings can be cured in the presence of temperature-sensitive components; good physical properties such as adhesion to the board; transparency so color coding can be recognized; easy application in the required thickness.

Although the ideal coating which will meet all of the above requirements has not been found, coatings can be selected which will most closely meet the desired application.

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Grounding Wiring Boards

AFTER installation of the assembled etched-wiring boards on the metal chassis with self-tapping screws, an operator on Admiral's assembly line solders certain of the screws to the chassis to insure good per-

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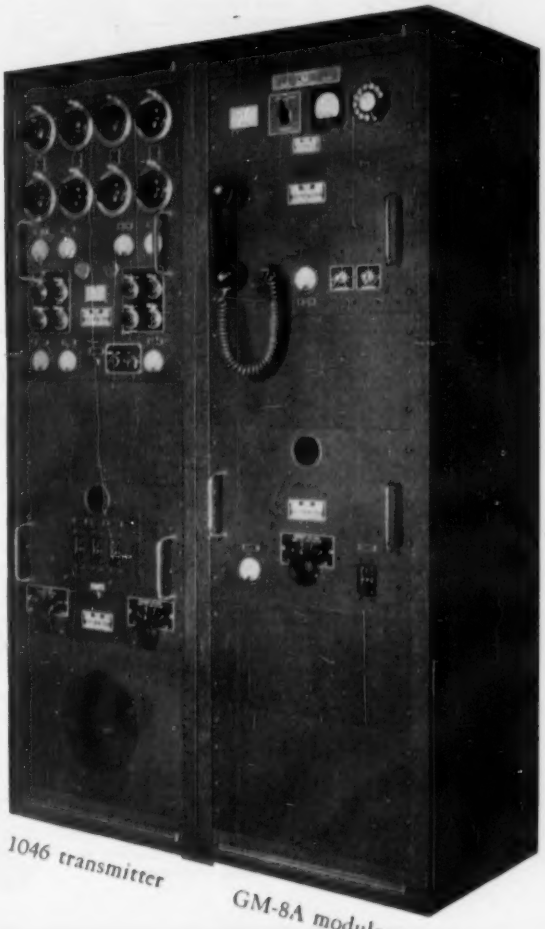
Complete technical data on request



1046 transmitter GM-8A modulator

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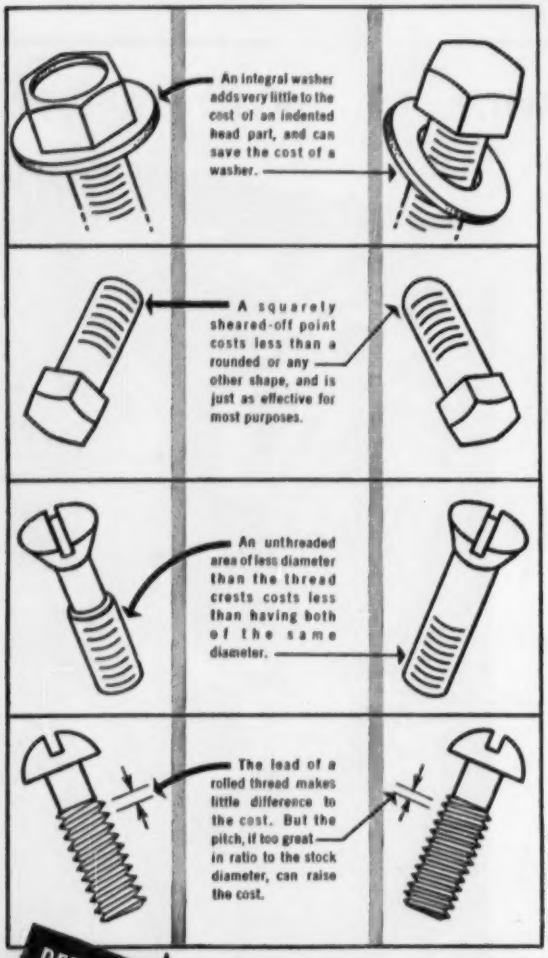
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An unthreaded area of less diameter than the thread crests costs less than having both of the same diameter.
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Wire-cutting machine with terminal attacher at right end. Reel of prefabricated terminals can be seen at upper right, with wire supply reel just below. Terminals are attached at only one end of each lead. Wire printer, not shown here, mounts on bar projecting at left of machine

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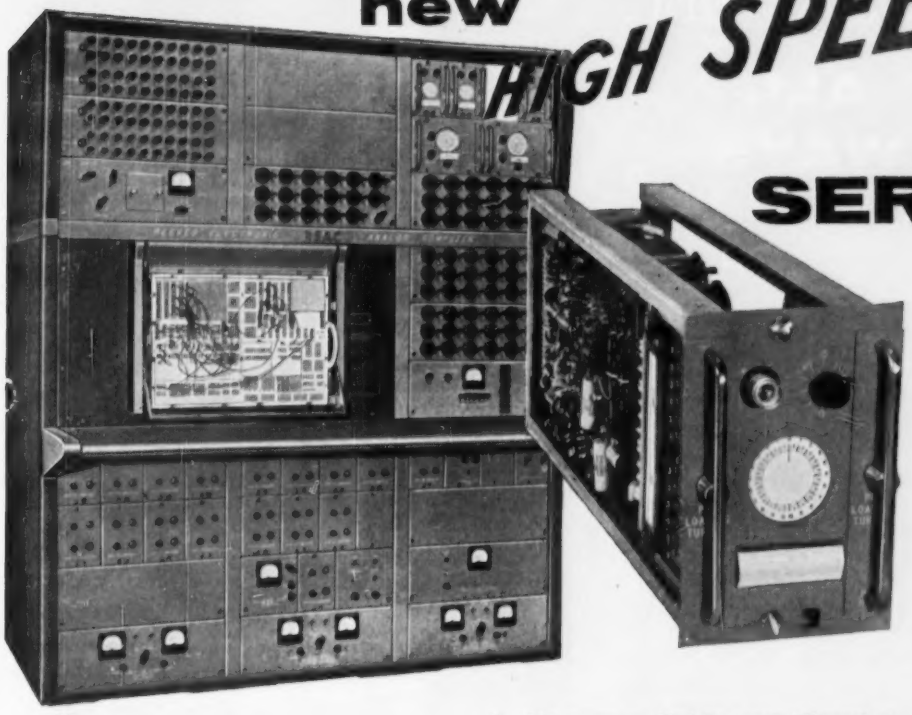

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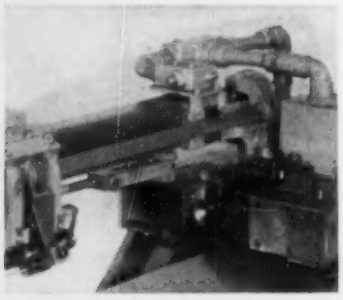
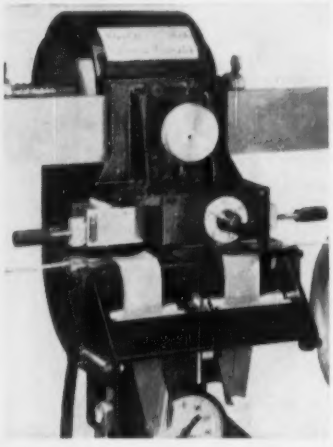


Terminal attacher, showing cone-shaped die into which the traveling overhead wire gripper pushes the stripped end of a lead



Lead-marking attachment mounted on steel bar at input end of machine

erated by unskilled labor once it is set up. Die units are simply and quickly changed.

► **Terminals**—The motorized terminal attacher is mounted at the right-hand end of the machine and synchronized with the operation of the wire cutter. The traveling overhead wire-gripper pulls out the wire the desired distance for cutting, then moves further to the right to bring the stripped end into the terminal die unit. Simultaneously, a switch is actuated by the overhead mechanism to operate the terminal-attaching unit. Various types and sizes of terminals can be handled if available in strip form on reels.

► **Printer** — The attachment for printing identifying nomenclature on the wire is clamped to a steel bar projecting out from the input of the machine, so that printing is done before cutting and stripping. This bar also supports the

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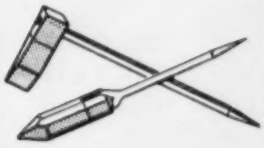

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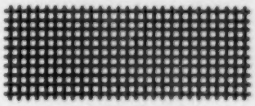
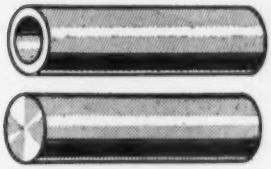


INDUSTRIAL WIRE CLOTH



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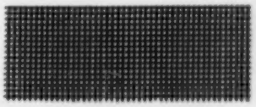
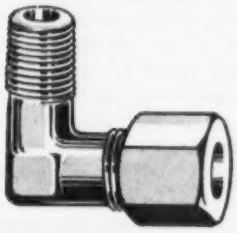


BRASS STRAINER CLOTH



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CALL US FOR ANYTHING from Bearing Bronze Bars to Brass or Bronze Bolts... or other fastenings like those shown here for maintenance, repair, operating or production. Twenty-five Chase warehouses are located in major industrial centers from coast to coast. Phone the one nearest you. We can usually fill your orders from stock.

NEW! Chase's informative rod and wire movie: "IN THE CHIPS." Arrange for a free loan of this film by contacting the Chase warehouse or sales office near you. Write on your company letterhead, today!

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AMPLIFIERS

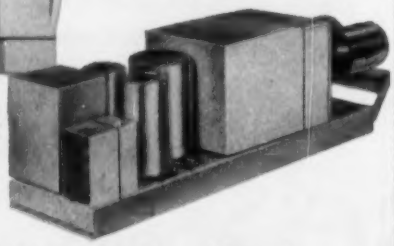
No matter which way you look at it, the LCM 5000 SERIES is the smallest size, high quality amplifier

- LENGTH – 9"
- WIDTH – 1⅜"
- HEIGHT – 3"

MODEL 5116 PLUG-IN
BROADCAST PRE-AMPLIFIER

(ACTUAL SIZE)

Quality deserving the serious consideration of responsible engineers



MODEL 5117 PLUG-IN
BROADCAST PROGRAM AMPLIFIER

- LENGTH – 10¼"
- HEIGHT – 3"
- WIDTH – 2⅝"

Complete specifications for the 5000 Series, including amplifiers and power supplies, available on request. Phone, write or wire today.

LANGEVIN MANUFACTURING CORPORATION
47-37 AUSTELL PLACE, LONG ISLAND CITY 1, N. Y.
Telephone: RAvenswood 9-1860

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compensating mechanism for the wire prefeeder. The printer is a dual unit, with the printing units about 3 inches apart. The printer is positioned in such a way that it is centered on the point at which the wire will later be cut. It operates each time the wire puller stops, so as to give a printed identification near each end of each lead.

Production of Curved Etched-Wiring Boards

POST-FORMING of etched-wiring boards has been placed on a production basis in the Minneapolis plant of Bureau of Engraving, Inc. Thermocontact presses provide preheating and special rollers do the actual forming.

Partially cured laminates, rigidly tested for forming ability, shrinkage, delamination and ability to hold the radius after forming are used for the base material. Nylon-base phenolics and glass-base epoxy resins are examples of materials that have proved satisfactory.

▶ **Forming Procedure**—After the board is etched on one or both sides, it is placed in a timer-controlled hot-plate press for 30 to 120 seconds at 250 F to 350 F, depending on the material. High-temperature rubber plates in the press provide good overall thermal contact. The timer automatically opens the press at the end of the selected heating cycle. The board is then immediately transferred to a specially designed roller-type press for the actual forming.

The board is sandwich-rolled

Placing board in heating press to soften base material

The "skin" we love to watch

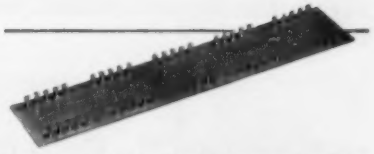
The "skin," or plated coating, on CTC terminals gets extremely close scrutiny from our quality control engineers. And we take pleasure in this careful watching because —

We know, as a result, that you can depend on CTC terminals for electroplated coatings of guaranteed minimum thickness — whether to government specifications or your own.

Our "watching" of these coatings includes periodic bend tests for adhesion, and periodic microscopic inspection of cross sections for coating thickness. These are but two of many examples of quality control that enable us to offer customers *guaranteed* electronic components . . . custom or standard.

Besides terminals, we pay close attention to the production of CTC terminal boards, capacitors, swagers, hardware, insulated terminals, coil forms and coils. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Terminal Data: Our standard terminal line includes 30 types, each in varied shank lengths. Made of silver plated brass, coated with water dip lacquer to keep them chemically clean for soldering. Also available: combination screw and solder terminals in 3 sizes, and a complete line of phenolic and ceramic insulated terminals. All materials, processes and finishes meet applicable government specifications. Special order finishes include hot tin, electrotin, cadmium plate or gold plate.



Standard CTC Terminal Boards as well as those made to your own specifications by CTC are available. Standard in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

Direct, accurate measurements of signal components—15 to 500 kc

Model 121 Wave Analyzer

This new Sierra Wave Analyzer is designed to give you maximum operating ease, high accuracy and broad applicability in analyzing complex wave forms between 15 and 500 kc. The instrument is particularly useful for carrier system frequency analysis and induction studies, for determining filter transmission characteristics, or for measuring distortion and intermodulation components of rf signal sources and transmitters.

The Model 121 makes possible direct measurement of signal components throughout its range, and eliminates complex expensive setups with conventional receivers and signal generators. Input level range is + 42 to – 70 dbm at 600 ohms impedance. Measuring accuracy is ± 2 db; selectivity is such that response is 45 db down at 1 kc off resonance. Input bridging impedance is 10,000 ohms in the pass band.

Model 122
LINE-BRIDGING TRANSFORMER

The Sierra 122 Line-Bridging Transformer instantly converts Model 121 Wave Analyzer from single-ended to balanced input. The transformer is a broad band ferrite core unit operating flat within 0.5 db. from 15 to 500 kc. It is compensated so that Analyzer readings are corrected for the transformer's small insertion loss. Offered in three impedances: Model 122A, 135 ohms; 122B, 500 ohms; 122C, 600 ohms.

For complete information see your local Sierra sales representative or request Bulletin 103A

sierra

Sierra Electronic Corporation
San Carlos 2, California, U. S. A.
Sales representatives in major cities

Manufacturers of Carrier Frequency Voltmeters, Wave Analyzers, Line Fault Analyzers, Directional Couplers, Wide-Band RF Transformers, Custom Radio Transmitters.

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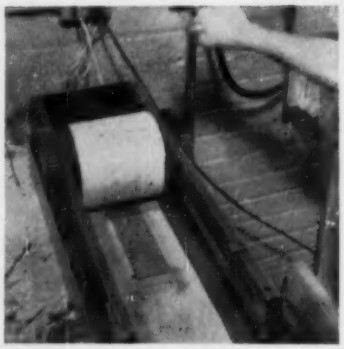
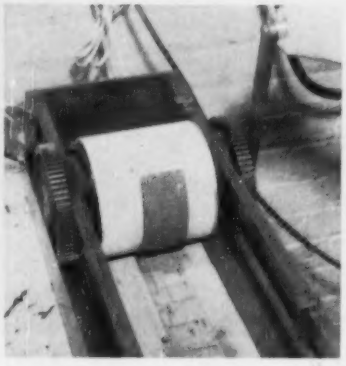


Board in loading position on bed of forming press



Curved board emerging from roller after slow cooling

within a felt layer that extends the cooling time to prevent thermal shock. Even pressure of the roller prevents damage to the delicate wiring on both sides of the board, permitting forming to an inside radius as small as three times the thickness of the material. Studs and components are now added after forming, but experiments are under way involving forming after insertion of components.

Locating Heater Shorts

WHEN a cathode-heater short develops during aging of tubes in batches of 100, a heavy-duty relay or switch is closed to burn out the heater and thereby eliminate the short. This technique saved $375.00 per year when first introduced in Sylvania's Emporium plant as a result of a suggestion by Donald Crawford.

The previous technique involved pulling tubes out of the aging rack one at a time until the shorted tube was located. This meant pulling up to 100 tubes.

John O. Gantner, Jr., President of Gantner of California, reveals why

"She always has the last word!"

"They say a woman will always have the last word. It's certainly true when she shops for a swimming suit!

"She waits till the last possible minute, and insists she get the 'last word' in style. Pressure on stores is terrific. If 'hot' styles run out of stock, those sales are gone forever.

"But our retail accounts know they can depend on Gantner.

"Gantner styles can be restocked to any store in the country in a few hours, *while the ads are running*. Not a moment is lost — not a sale is lost — thanks to Air Express!

"And one last word — about costs. Specifying Air Express can save you money, too. 15 lbs. from San Francisco to Chicago, for example, costs $10.91. That's $1.09 less than any other complete air service!"

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* **RAILWAY EXPRESS AGENCY**

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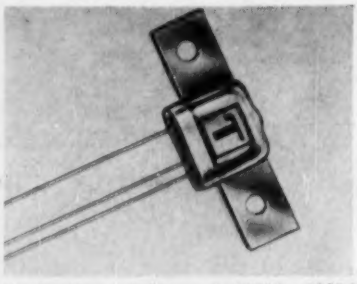
New Products

Edited by WILLIAM P. O'BRIEN

71 New Products and 63 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

TRANSISTORS
of the medium-power type

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. The new medium-power type transistors are designed for high power dissipation with linear operation over a wide collector current range. They are hermetically sealed under vacuum to insure reliability under the most severe operating conditions.



Efficient thermal connections provide greater power dissipation at elevated temperatures (up to 750 mw dissipation at 25 C). Maximum dissipation ability of 2N85, 2N86 and 2N87 medium power transistors is obtained by chassis mounting

▶**Output**—These transistors are intended for Class A or B output or driving stages, and will provide high output with a minimum of distortion. Approximately 1.5-w output can be obtained from a pair of 2N86 medium-power transistors operated in push-pull class B, even at temperatures up to 70 C when mounted on an aluminum chassis for heat-sink purposes.

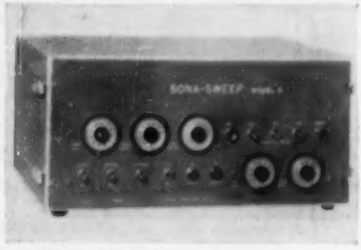
Prices range from about $3.00 each to approximately $4.50.

PLUG-IN MODULES
use standard component bodies

ERIE RESISTOR CORP., Erie, Pa., announces a new packaged subassembly that can be mass-produced at an overall cost approximating that of individual components, while greatly reducing the cost of assembly labor and equipment. Called PAC, for Pin Assembly Circuit, the new module permits installation of resistors and capacitors as a unitized plug-in package in etched wiring boards either manually or by machine, for lower-cost tv and radio sets, computers, industrial controls and other military or commercial electronic equipment.

The modules employ standard composition resistor and ceramic tubular capacitor bodies without leads, fitting into miniature fuse clips anchored in holes along the sides of the XXXP phenolic base plate. Interconnecting wiring is applied to the other side of the plate by an embossing process giving the equivalent of etched wiring without immersion in chemical solutions.

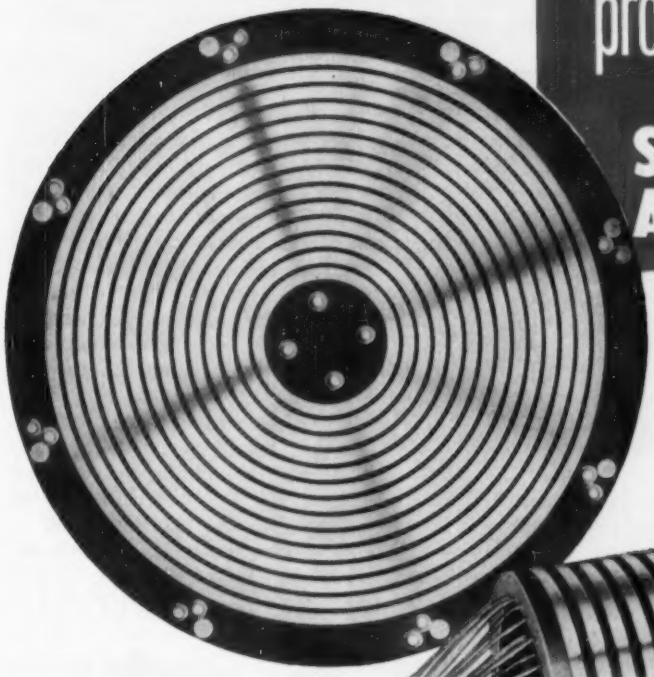
▶**Components**—Development engineers can readily make their own experimental modules. Up to 92 individual components may be combined by using an appropriate length of base plate, for insertion in a single operation. Basic component size is ¼ inch diameter and ¾ inch long, for which resistors are rated as ½ watt and 500 volts, with tolerances of 5 percent or wider, in values from 5 ohms to 50 megohms. Multiple pins are connected in series or parallel for higher wattage ratings. Capacitors range from 1 to 5,100 $\mu\mu$f. The adhesive bond of the conductive pattern on the back will withstand solder dip temperatures up to 570 F for 2 sec immersion or 10 sec at 500 F.



SWEEP GENERATOR
with sync pulse added

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has announced the Sona-Sweep model TV, which permits overall visual examination of the low end of the video spectrum. Features include separate

Now available the revolutionary ELECTRO TEC* process for your LARGE SLIP RING ASSEMBLIES



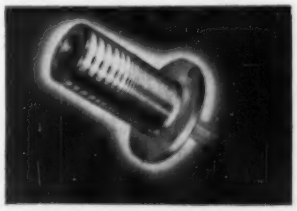
featuring

- LOWER COST
- CLOSER TOLERANCES
- ONE-PIECE CONSTRUCTION
- JEWEL-LIKE FINISH
- UNIFORM RING HARDNESS
- REDUCED WEIGHT

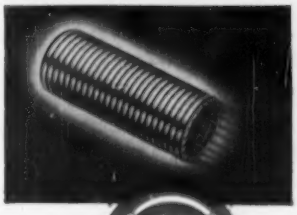
Now a Complete Service in all sizes of Slip Ring Assemblies

An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".

Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. 5⅜".



An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.



Cylinder type assembly approx. 3¾" long with 24 hard silver rings. 1⅜" O.D. with wall thickness less than ¼".

•PAT. NO. 2,696,570

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 36" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—70-95 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

Every user knows the ELECTRIC TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

ELECTRO TEC CORPORATION

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controls on sync pulse and sweep generator, r-f output and adjustable equalizer for better than 0.5-percent accuracy in any one region in the band.

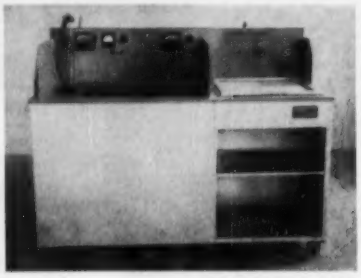
Blanking is added to provide zero level base line; permits locking of scope at test receiver end. Output is attenuated in steps for all of the sync and sweep pulse signal. A frequency vernier control permits observation of specific portions of the spectrum when sweep is turned down to narrow range.

▶**Specifications**—Range is 0 to 350 kc; r-f output, 0 to 1 v peak-to-peak into 75 ohms; flatness of sweep over entire range, 0.5 percent; output attenuator, 2, 4 and 6 db for whole signal; variable sweep rate, 2 to 0.5 cps; variable sweep width, 0 to 350 kc; sync pulse output, 0.3 to 1 v into 75 ohms; sync pulse duration, 5-milliseconds; sync pulse frequency, adjustable 15,750 cps ±750 cps (accuracy: ±10 cps).

PROTOMAKA

makes etched circuit in ½ hr

PRINTED ELECTRONICS CORP., 15 Willow St., Natick, Mass. The Protomāka, a unit for making production prototypes of printed electronic circuits, measures only 60 in. long by 50 in. wide by 45¼ in. high, but can produce an average printed circuit in only 30 to 40 min. Circuits up to 10 in. by 16 in. in size can be manufactured.



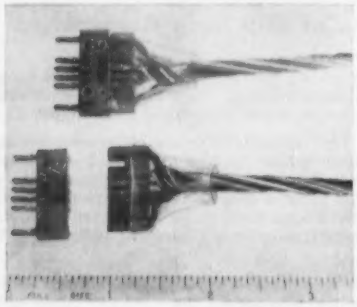
▶**How It Works**—The Protomāka is simply plugged into a standard 110-v line, one hose is connected to a cold water faucet and another to a waste drain. With these simple connections the unit is ready to operate. It produces etched wiring by the photographic process. Copper clad material is coated with photosensitive resist on a whirler. The board is held by a pair of quick-acting clamps while the solution is poured on the surface. Centrifugal force spreads the resist evenly, any excess flowing into the aluminum bowl in which the whirler spins. An infrared lamp dries the resist as the piece rotates. The circuit board is then exposed on the light table where the negative is placed under the resisted panel, and pressed firmly to it by the vacuum frame table top. Exposure time is only 30 sec. A developing tank with an overflow water rinse is conveniently located to complete the printing cycle.

The compact unit will sell between $3,000 and $3,500.

MALE CONNECTOR

ups printed circuit progress

CIRCON COMPONENT CO., 17544 Raymer St., Northridge, Calif., announces the new male connector for electronic, instrument and printed circuit uses. Available in both miniature and subminiature series, the connectors show five improvements over previous models.



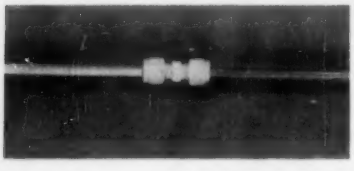
They provide higher insulation resistance and humidity performance due to new phenolic base material which exceeds all requirements of MIL-P-15035, type PRE-P. A sustained near-perfect contact is maintained with the new shot-burnished gold deposition process employed in the production of the contact surfaces.

Interface bond between the contact and the body of the connector is such as to eliminate virtually any damage to the contact bond due to careless application of wires to contacts. Increase in width of extremity contacts provides sound cabling and relief of strain at these critical points. Vinyl insulating hood provides built-in mold for potting of connectors should user desire.

▶**Prices**—A schedule is available listing prices of 16 models (subminiature and miniature series), which range from 73 cents to $4.72. Quantity discounts are also shown.

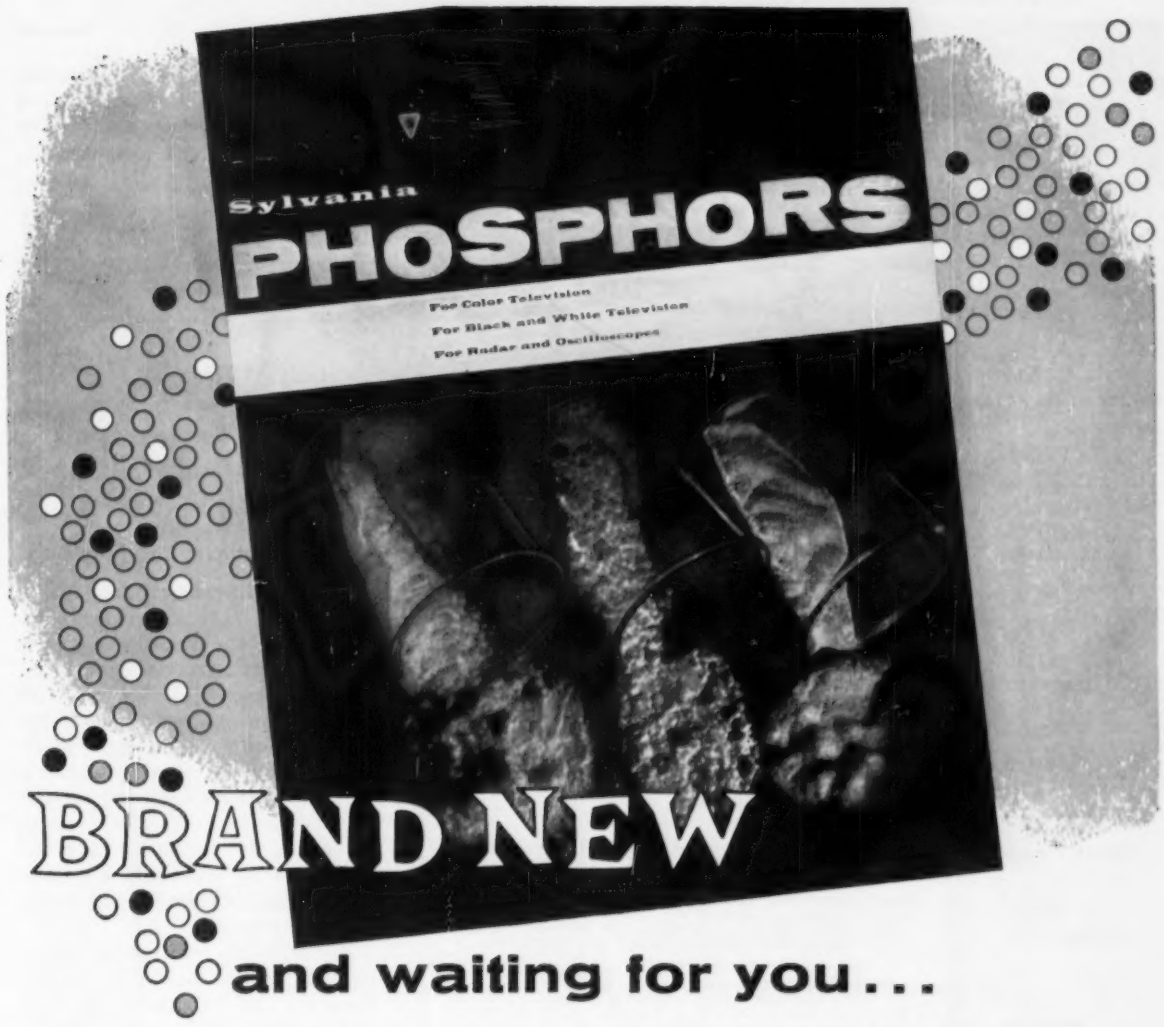
GALVANIC INSULATORS

of Zytel polyamide resin



CRAWFORD FITTING CO., 884 E. 140th St., Cleveland 10, Ohio, has announced the latest addition to the line of Swagelok tube fittings—Swagelok galvanic insulators of Zytel polyamide resin. The insulators offer a new method of eliminating galvanic action which results from joining dissimilar metals.

▶**Uses**—With their use, brass, aluminum, copper and steel may now be joined. Moreover, they will find many applications at junction



BRAND NEW

and waiting for you...

INTERESTED in high-purity phosphors . . . for color, black and white television tubes . . . for radar or oscilloscope tubes? Here is your opportunity to get the latest information directly from Sylvania—your prime source of phosphors and screen settling chemicals.

This new 24-page publication contains specifications and more than forty performance charts to guide in the selection of phosphors for every application. You will find helpful hints on almost every page, based on Sylvania's own experience in manufacturing the world's finest television and cathode ray tubes.

Something worth keeping in mind, too: Sylvania phosphors and chemicals are manufactured under a rigid control system that assures high performance from *every* batch. Prove this to your satisfaction by placing your next order with Sylvania!

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TENSOLON
WIRE & CABLE

. . . for −90°C to +250°C operation

A *Tensolite* PRODUCT

For an extra margin of dependability at maximum operating temperatures, specify Tensolite's rugged Teflon* insulated wire and cable products. Resistant to all chemicals and solvents, Teflon combines minimum wall thickness with highest dielectric strength. *Du Pont

TEFLON INSULATED HOOK-UP WIRE	**Extruded Teflon** insulation to meet the requirements of MIL-W-16878A Types E and EE, sizes 10-30 AWG in 14 solid colors and spirally striped. **Parallel wrapped Teflon** – exclusive patented construction featuring super-flexibility, sizes 20-34 AWG in 14 solid colors to MIL-W-16878A Types E and EE. **Spiral wrapped Teflon** – special cross-lapped construction with spiral striping conforming to commercial (GEN-104) and military (MIL-W-76A) specifications having the standard stripe width, lay and spacing. Sizes 8-30 AWG to MIL-W-16878A Types E and EE Specification. **NEW 5 mil wall subminiature Teflon hook-up wire** for applications where space factor is extremely critical. Sizes 26, 28, 30 and 32 AWG in 4 solid colors.
TEFLON LEAD WIRE	**Teflon impregnated fibreglas braid** over Teflon insulated wire for high temperature motor and transformer leads. Sizes 8-32 AWG, solid and tracer colors. **Silicone lacquered fibreglas braid** over Teflon insulated wire for class H applications. Sizes 8-32 AWG, solid and tracer colors.
SHIELDED TEFLON WIRE	All of the above described hook-up and lead wires are available with closely woven wire braid shields to all military and customer specifications. **100% shielding provided** with a close-fitting drawn copper or aluminum tubing available on request.
TEFLON TUBING	**Ultra-flexible** slip-on insulation for 20-30 AWG sizes available in 14 solid colors.
TEFLON AIRCRAFT WIRE	New improved Teflon-glass-Teflon sandwich construction providing superior resistance to abrasion and vibration, as well as increased margin of safety for overload protection and emergency operation. Conforms fully to MIL-W-7139A, available in sizes 6 to 22 AWG.
JACKETED SHIELDED TEFLON INSULATED CABLE	**Teflon outer jacket** cross-lapped and fused to provide an impervious and flexible covering completely resistant to all corrosive chemicals. Available in 10 solid colors, or spiral striped, sizes 10-30 AWG. **Teflon impregnated or silicone lacquered fibreglas** braid outer covering over shielded Teflon insulation. These class H cables are available in solid and tracer colors, sizes 10-30 AWG. **Extruded vinyl or nylon jackets** over shielded Teflon wire for high frequency, moderate temperature applications. All standard sizes and colors. **Nylon lacquered nylon braid** outer covering over shielded Teflon wire for extra rugged applications at temperatures not exceeding 120°C. Solid colors and tracers, sizes 10-30 AWG.
MINIATURE TEFLON COAXIAL CABLE	**50, 70 and 93 ohm extruded Teflon** insulated miniature coaxial cables with extruded vinyl, nylon or Teflon outer jackets. Also available with lacquered over-braids. **Finished coaxial cable assemblies** are now being supplied with miniature connectors and fittings. **Copper or aluminum clad miniature Teflon** insulated coaxial cables for rugged applications with extreme size and weight limitation. The semi-rigid nature of this construction minimizes self-generated noises. **Flexible low-noise miniature Teflon** insulated coaxial cables are also available on request.
MULTI-CONDUCTOR TEFLON CABLE	**Teflon insulated conductors cabled** together to exact customer specifications. **Shielded multi-conductor Teflon** insulated cables. **Teflon outer jacket,** silicone or Teflon impregnated fibreglas braid and nylon lacquered nylon braid over shielded multi-conductor Teflon insulated cables are available for numerous specialized applications in tele-metering and instrumentation.
CUSTOM TEFLON CABLE	Tensolite's development facilities are ready to assist you in the design and selection of special Teflon wire, cable and thermocouple constructions as well as custom wire assemblies and harnesses.

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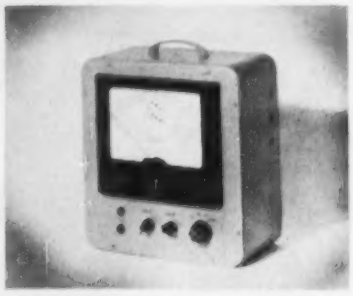
Tensolite **INSULATED WIRE CO • INC**

198 MAIN STREET, TARRYTOWN, NEW YORK

boxes, panel boards and bulkheads.

The insulators are made in a complete line of shapes and in ¼ in. to 1-in. tube and pipe sizes.



VTVOM
gives automatic reading

LEITCH ENGINEERING CORP., Manchester, N. H., has announced a new vtvom, the Meter-Matic, with completely automatic range switching. Application of the probes to points being checked gives an immediate reading on a large 8½-in. meter. Each set of calibrations is complete without the need of adding zero multipliers. Measurement of a-c and d-c voltages is from 0.1 v to 1,500 v. The unit is particularly valuable when dealing in unknown voltages.

Similarly, in measuring resistance, automatic reading is possible from 0.5 ohm to one billion ohms in 6 ranges.

▶ **Protection**—The entire instrument is protected from burn-out or damage up to 2,000 v. On ohms the unit is similarly protected against accidental application of voltages up to 300 v, a-c or d-c. This protection applies equally to the equipment under test.

The entire unit sells for $149.50.

SUBMINIATURE RELAY
1 sec to 5 min delay

FALCON ELECTRONICS CORP., 308 William St., Harrison, N. J., has

"Agreed! Airfreight's the best way to ship them. But, which do we use?"
"American! Traffic says they're the most experienced. Able to provide fast, dependable service."

To be certain of rapid and reliable deliveries, specify shipment by American Airlines Airfreight. In addition to being the most experienced, American also leads all other airfreight carriers in:

CAPACITY - with the largest cargo capacity of any airline, American has space where it's needed, when it's needed.

COVERAGE - with routes to more key industrial areas, American is able to provide the most direct one-carrier service.

SCHEDULES - with the most frequent schedules, American keeps terminal time to a minimum, assures you of prompt forwarding.

For complete information about the advantages of shipping American, wire collect to American Airlines, Inc., Cargo Sales Division, 100 Park Avenue, New York 17, New York.

AMERICAN AIRLINES AIRFREIGHT

- carries more airfreight than any other airline in the world

Want more information? Use post card on last page.

SUPERSEDES 100-1000 MC SLOTTED SECTIONS!

- READS VSWR AND REFLECTION COEFFICIENT ANGLE *DIRECTLY*
- SMALL AND COMPACT
- LOW IN COST

The PRD Type 219 Standing Wave Detector is the *small package, low cost* solution for making measurements easily and accurately in the 100 to 1000 mc/s region. By connecting the output to a VSWR indicator, such as the PRD Type 277, VSWR may be read directly on the indicator meter. No special detection equipment is required. The reflection coefficient angle is easily determined merely by rotating the top drum dial to a minimum indication on the meter and reading the angle on the dial *directly in electrical degrees.* No calculations are required. The probe and crystal detector are self-contained.

Usually it is more convenient to work with VSWR and reflection coefficient angle directly instead of with other components of the measured impedance. When other quantities are also of interest, they can easily be read from a conventional impedance chart. Only $475 f.o.b. N.Y. Write for PRD Reports, Vol. 3, No. 2, and for 1955 catalog.

SPECIFICATIONS

Frequency Range: 100 to 1000 mc/s

Residual VSWR: Less than 1.05

Accuracy of Reflection Coefficient Angle: Better than ±5°

Characteristic Impedance: 50 ohms

Output Terminals: Type N jack. Other interchangeable connectors

Min. Input Signal: Approx. 1 volt at 100 mc/s, 0.1 volt at 1000 mc/s

Dimensions: 8" l. x 5" w. x 5¾" h.

Weight: 4½ lbs.

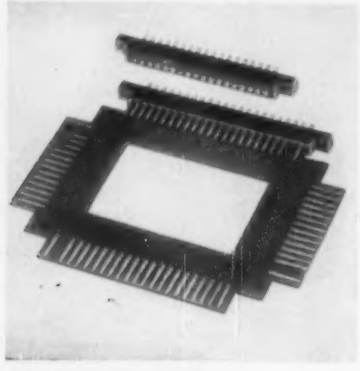
Polytechnic RESEARCH & DEVELOPMENT CO. INC

202 TILLARY STREET
BROOKLYN 1, N. Y.
Telephone:
ULster 2-6800

Midwest Sales Office:
1 SO. NORTHWEST HWY., PARK RIDGE, ILL. – TAlcot 3-3174
Western Sales Office:
741½ NO. SEWARD ST., HOLLYWOOD 38, CAL. – HO 5-5287

announced the new subminiature Shorty relay ideal for guided missiles and printed circuits. Height when seated is less than 1 in.

► **Specifications**—Delay range is from 1 sec to 5 min; power drain, approximately 4 w; heater voltages, up to 125 v (230 v available if required); interchangeable on d-c or a-c of any frequency; insulated for test voltages of 1,000 v a-c (1,250 v a-c on special order). Contacts are rated at 6 amperes 115 v a-c, noninductive load, 3 amperes d-c spst only. The relay is hermetically sealed, fully compensated for ambient temperature ranges of −60 C to +85 C; up to 125 C if required. It will withstand vibration of from 5 to 500 cps at accelerations of 10 g; shock up to 50 g.

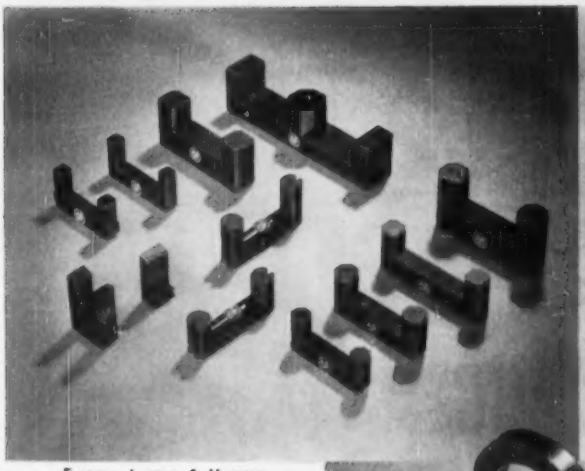


CONNECTORS
with Bellows type contacts

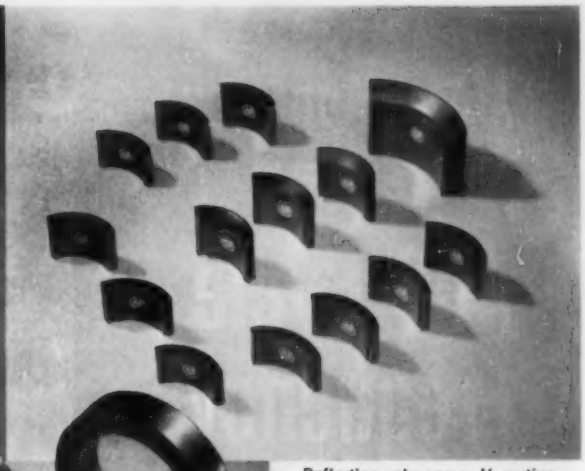
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. The newly developed Bellows type contacts are now supplied with the company's printed-circuit receptacles. They are available in single and double-row construction of 6, 10, 15, 18 or 22 contacts.

► **Features**—The new design provides longer contact life and smoother engagement. The connector accepts 0.054 in. to 0.071 in. variation of standard 1/16 in. copper clad printed circuit laminated card (receptacle to accommodate ⅛ in. board also available on special order).

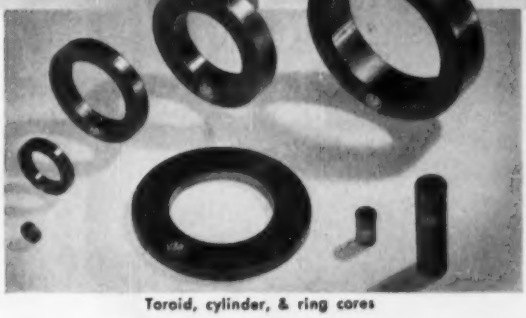
Wiring styles include solderless wire wrap, solder lugs or taper pins for AMP 53. A choice of mold-



E-cores, I-cores & U-cores



Deflection yoke cores—¼ section



Toroid, cylinder, & ring cores

HIGH EFFICIENCY FERRITE COMPONENTS

For TV and Electronic Circuits

Three performance standards—WO-1, WO-2, and WO-3—have been established for the performance characteristics of Allen-Bradley ferrite parts:—

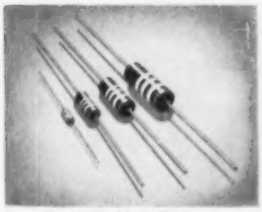
WO-1 and WO-3 are somewhat more efficient but are interchangeable with other makes of ferrite components.

Allen-Bradley WO-2 ferrite parts have much lower losses and higher permeability with greater flux density at maximum operating temperature. Their higher magnetic efficiency permits reduction in size of the ferrite parts and the use of less copper. Lower over-all cost is often the result.

In some color TV circuits, Allen-Bradley WO-2 ferrites have eliminated two tubes and related parts. It will pay you to investigate the use of Allen-Bradley ferrites in your electronic circuits.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt

Variable Molded Resistors
1/2 & 2 watt

Ferri-Cap Feed-thru Filters
with ferrite material

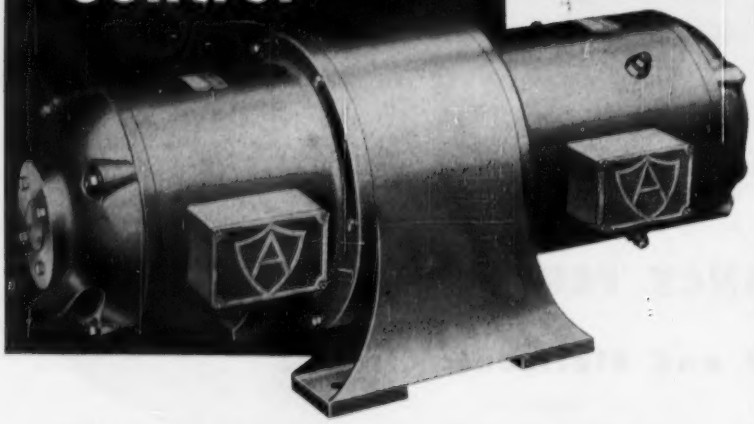
Ceramic Dielectric Capacitors
for by-pass and filtering

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

A New Approach To Precise 400 Cycle Frequency Control

with American Electric's Unique "MIC" DRIVE!



Here's the answer to *exceptional 400 cycle frequency control regardless of input frequency variations or changes in load!* It's the result of American Electric's "MIC" drive.. a MOTOR-INDUCTION COUPLING which produces a new standard of *automatic* speed control! No belts, no gears... speed changes are instantly sensed and automatically corrected electronically.

400 cycle output is held to ±¼% despite input frequency changes or load variations which ordinarily affect alternator rpm. *Even closer control is available for special applications!*

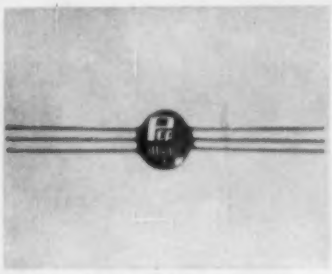
All other advantages of American Electric's proven alternator designs are retained. .low overshoot, fast transient voltage recoveries, low harmonic content, minimum maintenance.

Capacities: Single phase, ½ KVA to 40 KVA
Three phase, ½ KVA to 100 KVA
Write for quotations on your specific requirements

Application Engineering offices in principal industrial areas

American Electric Motors, Inc.
Electric Machinery & Equipment Division of
AMERICAN ELECTRONICS INC.
2112 Chico Avenue, El Monte, Calif.

ing compounds is available: mineral filled Melamine, Plaskon reinforced (glass) Alkyd 440A, and Orlon filled diallyl phthalate.



PULSE TRANSFORMER is highly miniaturized

PCA ELECTRONICS INC., 2180 Colorado Ave., Santa Monica, Calif. The MPT miniaturized pulse transformer is available in 2, 3 and 4 windings, and a pulse-width range of 0.01 to 25 μsec.

As an encapsulated unit, it is commonly mounted by soldering into a circuit. Because of its small size, there are no shock or vibration problems. The transformer meets MIL-T-27A, wherever applicable.

▶ **Applications**—It is ideally suited for: blocking oscillators, impedance matching and phase inversion; as wide-band input and output transformers; l-v interstage coupling; triggering and counting circuits; d-c isolation; pulse shaping and many other applications.

Prices range from $4.45 each to $8.05 each, depending on design and quantity.

POWER SUPPLY is focusing-magnet type

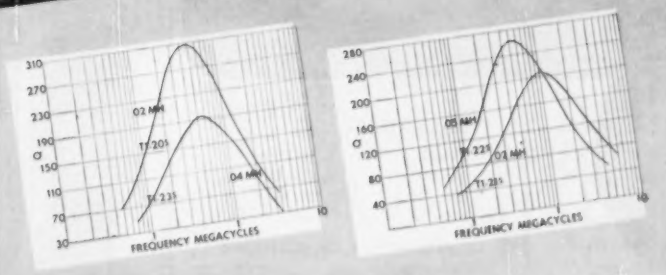
LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. Designed for use with

FEATURING TEMPERATURE COEFFICIENTS AS LOW AS
10 PARTS PER MILLION PER DEGREE C. BETWEEN — 55° AND +85°

NEW FREED
HIGH FREQUENCY — HIGH "Q" TOROIDAL INDUCTORS

PRODUCTS OF QUALITY — DEPENDABILITY RESULTS OF EXTENSIVE ENGINEERING

HIGH FREQUENCY TOROIDAL INDUCTORS featuring very high Q, temperature stabilization and low pickup utilizing the latest materials and techniques.



TI-20S 14 stock values from 0.05 Mhy. to 4.5 Mhy.

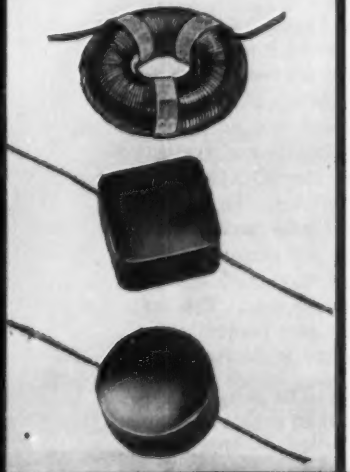
TI-23S 15 stock values from 10 Mhy. to 700 Mhy.

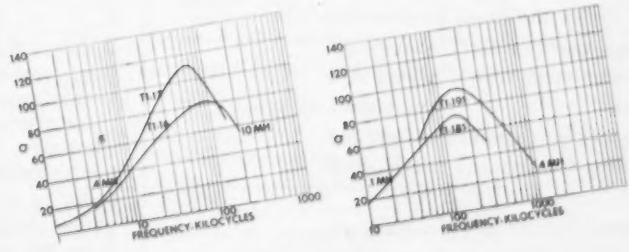
TI-21S 15 stock values from .01 Mhy. to 1 Mhy.

TI-22S 10 stock values from 10 Mhy. to 150 Mhy.

	OD	H
TI-20	1"	9/16
TI-21	5/8	5/16
TI-22	7/8	3/8
TI-23	7/8	3/8

Can be supplied hermetically-sealed, encapsulated or in a metal can.





TI-16 20 stock values from .1 Mhy. to 100 Mhy.

TI-17 18 stock values from .1 Mhy. to 100 Mhy.

TI-18 18 stock values from .1 Mhy. to 100 Mhy.

TI-19 13 stock values from .1 Mhy. to 5 Mhy.

THESE TOROIDS ARE FEATURING HIGH Q AND SUBMINIATURE SIZE. Our unique winding and impregnation process insures very low distributed capacity and consequently self-resonant frequencies far removed from the operating range.

NOW AVAILABLE FROM STOCK FOR IMMEDIATE DELIVERY

FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST., BROOKLYN (Ridgewood) 27, NEW YORK
Phone: EVergreen 6-1300

Which button?

Today at Martin, one of the finest engineering teams in the whole new world of flight systems development is at work on tomorrow's design and development problems.

Most of the people on that team are young—and moving ahead fast with a dynamic and fast-moving management.

Push any button and you can get the story of some of the exciting things that are happening there.

Contact J. M. Hollyday, Dept. E-12, The Martin Company, Baltimore 3, Maryland.

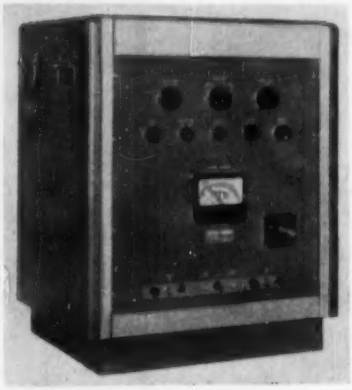
MARTIN
BALTIMORE

high-power klystrons and traveling-wave-tube focusing magnets, a continuously-variable 150-v 4-ampere power supply with less than 0.1-percent current ripple is now available.

It is designed to operate from 115-v 60-cps single-phase power.

▶ **Components**—Units include an undercurrent relay to interlock with tube beam supply and indicator light, main power switches, pilot light, and appropriate fusing.

The power supply is designed to fit standard 19-in. relay-rack mounting. Price is $275.



SWEEP GENERATOR
covers the entire X-band

ROGER WHITE ELECTRON DEVICES, INC., 12 West Island Road, Ramsey, N. J. The SWM-5 sweep generator is designed to permit rapid evaluation, measurement and adjustment of microwave circuits and systems.

Incorporating the BC-X10m backward-wave oscillator, the generator supplies a microwave signal swept in frequency across a waveguide range or any portion of it from 66 mc to 60 kmc. The unit can also operate as a manually controlled c-w source if desired.

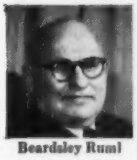
▶ **Sweep Width**—The range of frequencies covered in each sweep can be adjusted to cover the entire range or any portion as small as 10 percent of the band. This makes the unit equally useful for examining the performance of components over narrow bandwidths or across the full waveguide range.

Power output may vary as much

Now Puerto Rico Offers 100% Tax Exemption to New Industry

by BEARDSLEY RUML

"We don't want runaway industries" says Governor Muñoz. "But we do seek new and expanding industries." Federal taxes do not apply in Puerto Rico, and the Commonwealth also offers full exemption from local taxes. That is why 325 new plants have been located in Puerto Rico, protected by all the guarantees of the U.S. Constitution.



Beardsley Ruml

IN A dramatic bid to raise the standard of living in Puerto Rico, the Commonwealth Government is now offering U. S. manufacturers such overwhelming incentives that more than three hundred new factories have already been established in this sunny island 961 miles off the Florida coast.

First and most compelling incentive is the 100% tax exemption for most manufacturers who set up new plants in Puerto Rico.

For example, if your company is now making a net profit after taxes of $53,500, your net profit in Puerto Rico would be $100,000—a gain of 87 per cent, simply because Federal corporate income taxes do not apply in Puerto Rico and all local taxes are waived as well.

Your dividends in Puerto Rico from a corporation there could be $50,000 against $25,000 net in the U. S.—because Federal personal income taxes do not apply either.

What About Labor?

Puerto Rico's labor reservoir of 637,000 men and women has developed remarkable levels of productivity and efficiency—thanks, in part, to the Commonwealth's vocational training schools. These schools also offer special courses for managers and supervisors.

The progress made in technical skills may be gauged from the fact that there are now twenty-eight factories producing delicate electronic equipment.

Among the U.S. companies that have already set up manufacturing operations in Puerto Rico are Sylvania Electric, Carborundum Company, St. Regis Paper, Remington Rand, Univis Lens, Shoe Corporation of America, and Weston Electric.

CORPORATE TAX EXEMPTION

If your net profit after U. S. Corporate Income Tax is:	Your net profit in Puerto Rico would be:
$ 17,500	$ 25,000
29,500	50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

DIVIDEND TAX EXEMPTION

If your income* after U. S. Individual Income Tax is:	Your net income in Puerto Rico would be:
$ 3,900	$ 5,000
7,360	10,000
10,270	15,000
14,850	25,000
23,180	50,000
32,680	100,000
43,180	200,000
70,180	500,000

*These examples are figured for dividends paid in Puerto Rico to a single resident. Based on Federal rates effective Jan. 1, 1954.

"Close to Paradise"

Listen to what L. H. Christensen, Vice President of St. Regis Paper, says:

"The climate is probably as close to paradise as man will ever see. I find Puerto Ricans in general extremely friendly, courteous and cooperative.

"This plant in Puerto Rico is one of our most efficient operations, in both quality and output. Our labor has responded well to all situations."

Mr. Christensen might have added that the temperature usually stays in the balmy 70's twelve months a year.

The swimming, sailing and fishing are out of this world. Your wife will rejoice to hear that domestic help is abundant.

The Commonwealth will leave no stone unturned to help you get started. It will build a factory for you. It will help you secure long-term financing. It will even screen job applicants for you—and then train them to operate your machines.

Transportation

Six steamship companies and five airlines operate regular services between Puerto Rico and the mainland. San Juan is just 5½ hours by air from New York.

Light-weight articles such as radar components come off the line in Puerto Rico one day and are delivered by air freight next day in Los Angeles, Chicago and other mainland cities. And, of course, there is no duty of any kind on trade with the mainland.

Are You Eligible?

Says Governor Muñoz: *Our drive is for new capital. Our slogan is not "move something old to Puerto Rico," but "start something new in Puerto Rico" or "expand in Puerto Rico."*

To get all the facts, and to find out whether you and your company would be eligible for complete tax exemption, telephone our nearest office.

New York	MU 8-2960	579 5th Ave.
Chicago	AN 3-4887	79 W. Monroe
Los Angeles	WE 1-1225	5525 Wilshire

OR MAIL COUPON

Commonwealth of Puerto Rico
Economic Development Administration
579 Fifth Ave., New York 17, N. Y.
Dept. V4

Mail me "Facts for Businessmen." I am interested in the advantages of Puerto Rico for the industry I have checked.

☐ Electronics ☐ Plastics ☐ Apparel
☐ Leather ☐ Optical ☐ Metals

Other _____

Name _____

Company _____

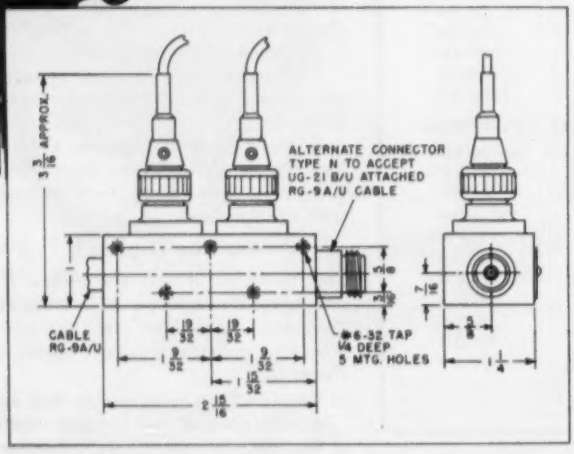
Address _____

_____

Want more information? Use post card on last page.

Memo to transmitter designers—

Specify MicroMatch Directional Coupler as built-in R.F. and VSWR monitoring equipment. Transmitter customers stay "sold" by the coupler's continuous RF power output indication. Its VSWR monitor is your customer's transmission line and antenna "watch-dog".



Outline Drawing Model 575N Double Coupler.

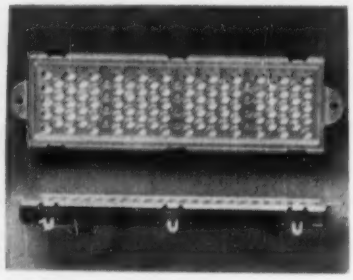
Performance proven, you will find these small, extremely low-cost MicroMatch couplers now incorporated in the most modern Government and commercial transmitters. MicroMatch Directional Couplers produce an output essentially independent of frequency over the range of 20 to 2000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurement is plus or minus 5% of full scale.

For complete details on the MicroMatch line of monitoring equipment, please consult Page 495 of Electronics Buyer's Guide, or, better still, write for our 46-page catalog.

M.C. Jones **M. C. JONES ELECTRONICS CO., Inc.**
BRISTOL, CONNECTICUT

as 10 db from minimum to maximum in the band but the variation over any 100-mc band is usually small.

Price of the unit is $2,800. A data sheet is available giving additional information.



LOUDSPEAKERS
Isophon electrostatic types

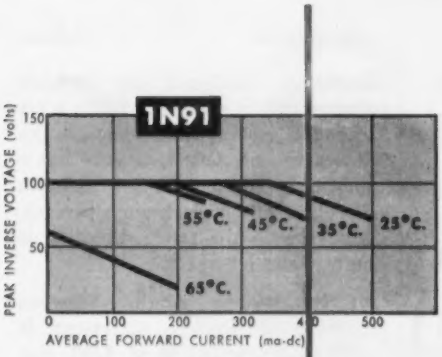
ARNHOLD CERAMICS, INC., 1 E. 57th St., New York 22, N. Y., announces the new Isophon line of electrostatic loudspeakers, manufactured in West Germany. Two types are available—the rectangular type St H ⁂ (illustrated) and round type St H B7.

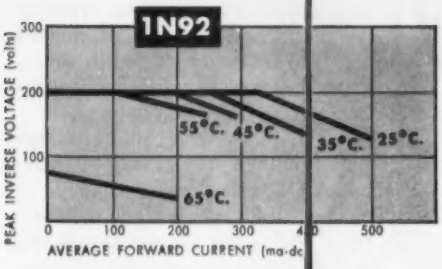
▶ **Frequency** — The loudspeakers are suggested for use over a 7,000 to 20,000-cycle frequency range. Special construction of the membrane results in far reaching and evenly distributed volume and sound even in the higher frequencies, where cone speakers often develop trouble.

The small size, in particular the thickness of less than 1 in., and the low cost make the speakers desirable for manufacturers of radio, tv, high-fidelity and other applicable sound equipment.

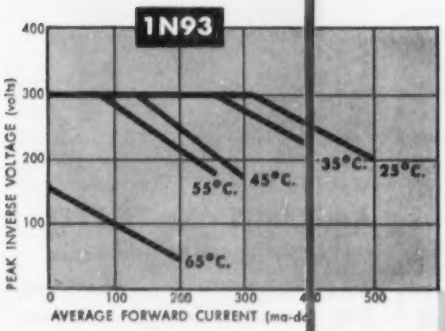
DEFLECTION YOKE
has high linearity accuracy

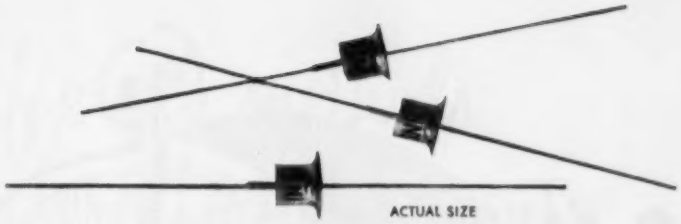
STANDARD COIL PRODUCTS CO., INC., 2085 N. Hawthorne Ave., Melrose





THREE TIMES ACTUAL SIZE





ACTUAL SIZE

CLEVITE TRANSISTOR PRODUCTS

IMMEDIATE DELIVERY

PRODUCTION QUANTITIES*

POWER DIODES

AN ADVANCE IN ELECTRONICS

Germanium Junction Power Diodes Types 1N91, 1N92, and 1N93 achieve characteristics never before possible in either thermionic or other types of solid state rectifiers. For example:

- **SMALL SIZE-HIGH POWER**—approximately four times the rectified power in the same space as other devices.
- **HIGH EFFICIENCY** — combines very low forward resistance with high back resistance . . . 100% rectification efficiency is approached.
- **LONG LIFE** — unlike other semi-conductor metals, Germanium does not age . . . in addition, hermetically sealed construction.

100% RIGID CONFORMANCE TO SPECIFICATIONS

Quality control of Clevite Transistor Products Power Diodes is based on a *100% sampling*. Each and every unit is individually tested for rigid conformance to specifications.

- **ELECTRICALLY TESTED** — each unit must meet or surpass performance requirements.
- **HIGH PRESSURE HUMIDITY TESTED** — each unit is checked to assure perfect hermetic sealing.

CLEVITE TRANSISTOR PRODUCTS

241-257 CRESCENT STREET
WALTHAM 54, MASSACHUSETTS

CLEVITE T P

A DIVISION OF THE CLEVITE CORPORATION

TRANSISTORS • DIODES • SEMI-CONDUCTOR DEVICES

ABSOLUTE MAXIMUM RATINGS (for 60 cycle, 55°C. resistive load)

	1N91	1N92	1N93
Peak Inverse Voltage (volts)	100 v. at 2.7 ma	200 v. at 1.9 ma	300 v. at 1.2 ma
Peak Forward Current (amps)	0.47	0.31	0.24
DC Output Current (ma)	150	100	75
DC Surge Current (amps)	25	25	25
Full Load Voltage Drop (volts)	0.5	0.5	0.5
Continuous Reverse Working Voltage (volts)	30	65	100
Operating Frequency (Kc.)	50	50	50
Storage Temperature (°C.)	85	85	85

* ARMED SERVICES and A.E.C. Source Inspection Available

Write for Power Diode Bulletin PD2

Want more information? Use post card on last page.

A midwestern electronics manufacturer has cut soldering time a full 60% by changing from cadmium plated to tin-zinc plated parts. As a result they increased assembly production by 250%.

Corrosion-resisting tin-zinc offers many assembly and plating advantages to manufacturers of electronic parts —

PRODUCTION — The soldering operation is made easier and considerable assembly time can be saved—parts can be soldered at lower temperatures . . . Embrittlement of fine wire is greatly reduced — solderability is retained longer *(even after 3 years* on the shelf tin-zinc plated parts have been soldered without difficulty) . . . Flux is not necessary.

PLATING — M&T tin-zinc plating is economical, easy, and assures a corrosion-resisting finish with good coverage even on difficult metals such as malleable iron.

M&T tin-zinc plating may solve your production problems, too. For detailed information on the process or technical assistance, write us without obligation.

METAL & THERMIT CORPORATION

Chemical & Metals Department

100 EAST 42nd STREET • NEW YORK 17, N. Y.

Park, Ill. Designed for accurate control of the spot position in a crt intended for radar application, the new precision deflection yoke has a linearity accuracy in the azimuth direction of better than ½ percent. Linearity in the range direction is better than ½ percent.

► **Orthogonality**—Angle between azimuth and range directions is held to an accuracy of 1/10 deg. This performance is brought about as a result of a special winding technique and the use of molded coil forms combined with equipment for measuring deflection accuracy to within 0.03 percent.

A cylindrical iron core surrounds the windings for shielding purposes. The entire assembly is pressed into a phenolic cylinder, then completely impregnated and sealed to prevent entrance of moisture.

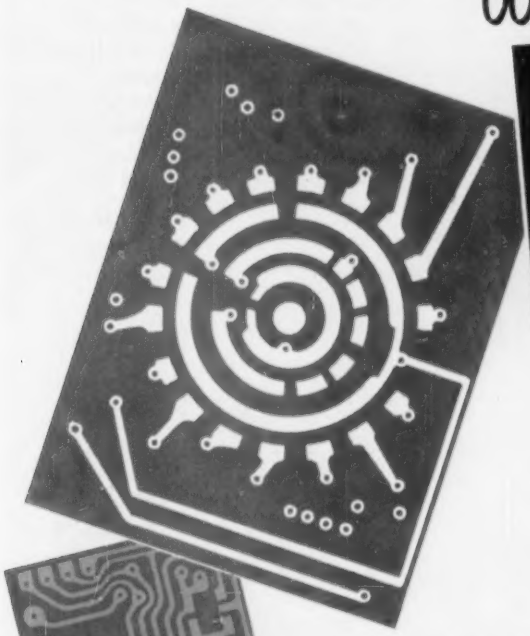
Dimensions are as follows: inside diameter, 1⅛ in.; outside diameter, 3⅛ in.; length, 3¾ in. Windings can be made to suit practically any specified requirement. Size can also be varied where required.

AMPLIFIER-VOLTMETER is highly sensitive

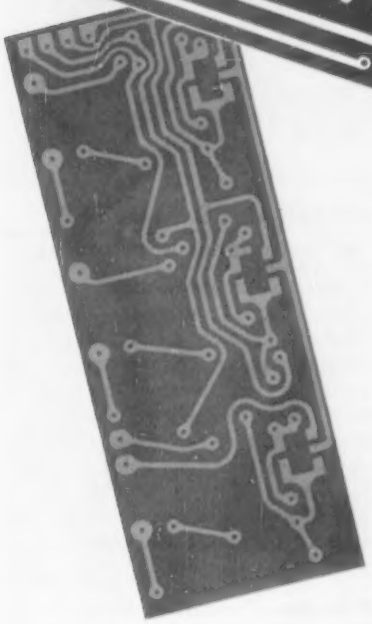
ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 346 sensitive amplifier-voltmeter can make precise measurements of a-c signals from 100 μv to 300 v at frequencies from 10 cps to 2 mc.

The 4½-in. meter scale is illuminated to facilitate use under low ambient light conditions. Readings are provided from −72 to +52 db. Calibration is in two linear voltage scales (0 to 1 and 0 to 3) and

NOW 2 different methods FOR 2 different requirements



AEROVOX PRINTED WIRING



You are now offered the choice of TWO different printed-wiring methods: (1) The Aerovox exclusive **Pressed Silver** or (2) The Aerovox **Etched Copper.** Each has its particular field of applications.

Furthermore, Aerovox also offers a choice of different base materials, such as: Phenolic-paper Base, Phenolic Fabric, Epoxy Glass, Melamine Glass, Teflon Glass, Polystyrene and Methacrylite, each with certain characteristics for given usages.

PRESSED SILVER

Produced by a hot die-stamp process in which the conducting pattern is mechanically embossed in one or both sides of the selected base material. Does not rely on any adhesive agent for the bond between conductive and base materials. Pure silver conductors are partially imbedded in base support. Compared with copper, the silver is more resistant to oxidation, solders more readily, and provides superior electrical contact surface with greater resistance to wear, particularly for switching applications.

ETCHED COPPER

Produced by applying an etch-resistant pattern on to a metal foil, usually copper clad. Unprotected metal areas of printed pattern are then etched away leaving desired wiring pattern. The resistant enamels may be applied by (a) Direct photographic means, or (b) Screen printing. The former achieves maximum definition of lines held to close tolerances at relatively modest costs; the latter effects cost savings where extremely fine detail is of secondary importance.

PRINTED WIRING PRIMER . . .

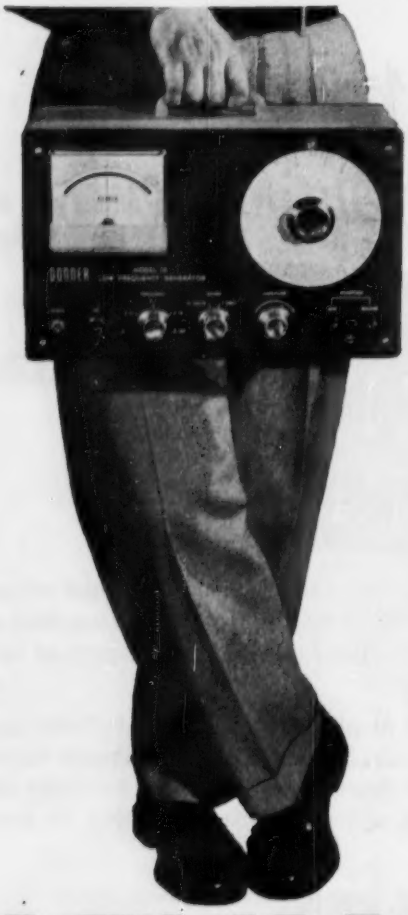
Write on your business stationery for this practical guide on printed wiring. And let our printed wiring specialists collaborate on your particular applications.

AEROVOX CORPORATION

SPECIAL PRODUCTS DIVISION

NEW BEDFORD, MASSACHUSETTS

In Canada: AEROVOX CANADA LTD., Hamilton, Ont.



True sine and square waves for servo, geophysical, and computer work. 0.01 to 1000 cps in 5 decades. High stability, low distortion. Accurate frequency calibration and precisely metered output.

DONNER MODEL 15
LOW FREQUENCY GENERATOR

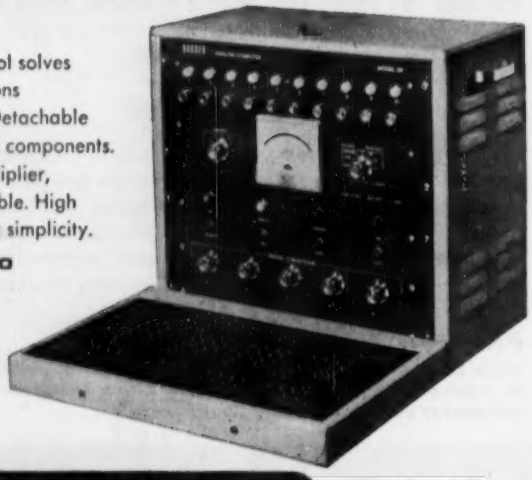
$365, F.O.B. Berkeley

ADVANCED INSTRUMENTATION

Versatile engineering tool solves both differential equations and transfer functions. Detachable problem boards, plug-in components. Function generator, multiplier, other accessories available. High accuracy with operating simplicity.

DONNER MODEL 30
ANALOG COMPUTER

$995, F.O.B. Berkeley



DONNER SCIENTIFIC COMPANY

2502 Seventh St.
Berkeley 10, Calif.

Complete Data on Request

a db scale (−12 to +2 dbm). The rectifier is of the full-wave average type to offer greatest accuracy when dealing in complex waveforms.

► **Specifications** — Meter ranges are 0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10, 30, 100 and 300 v full scale. Accuracy is ±3 percent, 20 cps to 1 mc; ±5 percent, 10 cps to 2 mc. Stability is ±1 percent at any line voltage between 105 and 130 v. Input impedance is 10 megohms shunted by 24 $\mu\mu$f.

► **Physical Characteristics** — It measures 6½ in. high, 4¼ in. wide and 7½ in. deep overall. Weight is 6½ lb.

Price of the unit is $200.

IMPEDANCE PLOTTER
for instantaneous recording

CHESAPEAKE INSTRUMENT CORP., Shadyside, Md., announces an automatic impedance plotter for instantaneous recording of real and imaginary components of impedance as a function of frequency, temperature or other variables. It eliminates point by point plotting procedure, thereby serving as a practical production control tool as well as a valuable research instrument.

► **Ranges**—Frequency range is 10 cps to 100 kc with a rated accuracy of ±2 percent. Resistance range is 0 to 10,000 ohms; reactance range, ±10,000 ohms.

The apparatus uses Mosely Autograf recorder which plots on standard 8½ in. by 11 in. graph paper.

► **Applications**—The AIP has demonstrated its usefulness in the de-

Picture Quality Is Our Business Too!

Set designers assure their customers steady, clear pictures by careful component selection. Good-All backs that selection with reliable capacitors at economical cost. The enthusiastic acceptance of **GOOD-ALL MARBELITE** and **SERAMELITE** tubulars is a measure of the confidence designers have in these capacitors. Tens of millions are in use today in TV and Radio Sets of leading manufacturers.

Good-ALL capacitors

MARBELITE — GOOD-ALL

Marbelite capacitors are best known for their physical and electrical ruggedness. The Good-All type 503-M capacitors provide solid plastic construction at a surprisingly low cost. A miniature series of Marbelites is also available for applications in which the space is limited.

SERAMELITE — GOOD-ALL

The seramelite family of capacitors is housed in ceramic tubes with end-seals of a tough, dense plastic. Their performance under conditions of high temperature and humidity is outstanding. Seramelite types with "MYLAR" dielectric are becoming increasingly popular.

Get full information by writing Good-All direct or by contacting our nearest sales representative.

GOOD-ALL ELECTRIC MFG. CO. • GOODALL BLDG. • OGALLALA, NEBRASKA

HOKUM ON PREAMPLIFICATION

Way out in our back room we have a section devoted to Engineering. One purpose of this group is to see to it that our relays work in the job for which our customers purchased them. Our man Waldo Hokum, one of the members of this group, has for years been untangling circuit problems that have had an unflattering effect on our relays and during this time he has been able to segregate many problems and assemble them in definite categories.

One category soon became so large that we had to take more floor space to make room for it — that was, and is, how to get conventional relay response to low impedance D.C. signals of the order of 0.1 to 100 microwatts. Many relay uses call for amplifying these signals so that they will be strong enough to activate even our most sensitive relays. This is especially important to people who work with photocells, thermocouples and the like.

Waldo stuck with this one through various stages of vacuum tubes, transistors, toroidal coil magnetic amplifiers and such, but never was really happy about his progress. There was always something like high cost, fragility or instability to cast a dark shadow on his otherwise blissful existence. It wasn't until he designed and made his own magnetic amplifier that he began to see the sunshine again.

What he came up with was a magnetic amplifier which, among other things, included conventional bobbin wound coils rather than toroids. This made our directors happy, because even they know that the manufacturing costs are *much* less with bobbins, and, what is more important, it made Waldo happy. He discovered that his new gismo, together with the circuitry that he developed to go with it, had some rather interesting specs, generally as follows:

MAGNETIC AMPLIFIER RELAY
SERIES 8000*

Sensitivity:	0.1 to 100 microwatts	
Nature of signal:	D. C. from 0.1 to 30,000 ohms	
Relay response:	Polarity sensitive — snap action	
Contact form:	(1) 3-position, center neutral (2) SPDT	
Contact rating:	1-5 amperes at 28VDC or 115VAC	
Speed of response:	30 to 300 milliseconds depending on overdrive and L/R of input circuit	
Environment:	Standard	Available
Vibration	5 g. to 30 cps.	10 g. to 500 cps.
Temperature	0° to 50°C	−55° to 125°C
Shock	10 g	100 g
Power Supply:	115V @ 60 cps.	115V @ 400 cps.

This thing is now at the point where it would be worth your time to play around with — that is if the above specs bracket your problem generally and especially if you need to monitor the conditions of bridge balance or compare the outputs of low impedance D.C. signal sources.

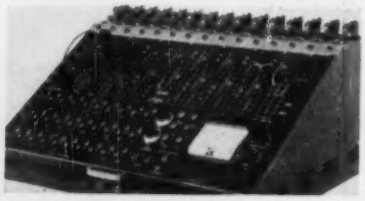
If such is the case, Waldo has some sample "packages" that not only include his magnetic amplifier, and a Sigma Relay (natch), but also the circuitry that makes the thing work. If you think you'd like one of these to fool with, or wish more information on this subject, we suggest you write to us, attention of our man Waldo. His name really is spelled Holcombe.

SIGMA

SIGMA INSTRUMENTS, INC.
62 Pearl St., So. Braintree, Boston 85, Mass.

sign and control of electroacoustic transducers, loudspeakers, electrical filters, electromechanical filters, microphones, accelerometers, transformers and similar devices.

Literature is available.



ANALOG COMPUTER
available in kit form

HEATH CO., a subsidiary of Daystrom, Inc., Benton Harbor, Mich., has available an inexpensive electronic analog computer in kit form. It incorporates such features as: 30 coefficient potentiometers, each of which is capable of being set to an accuracy of better than 0.1 percent; one standard reference supply for all d-c voltages; a nulling meter for accurate setting of computer voltages; and a unique patch-board layout which enables the operator to see his computer block layout.

► **Makeup**—The computer is comprised of the model ES-400 computer cabinet, model ES-200 amplifier, model ES-100 power supply, model ES-100 initial conditions and model ES-600 function generator.

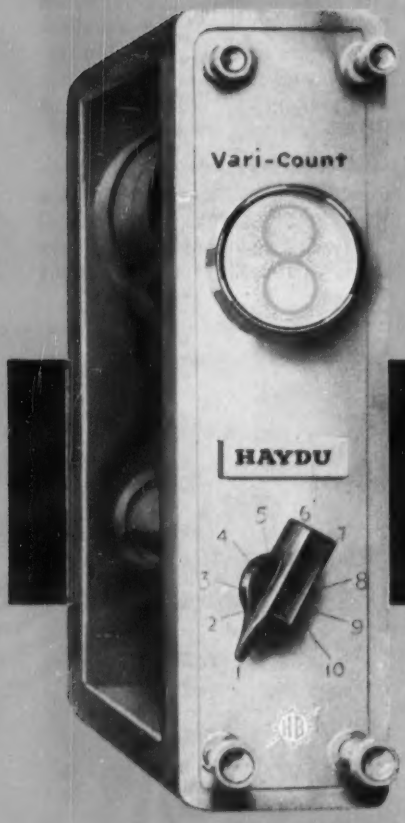
Selling price is under $700.

WIRE-WOUND RESISTORS
for mechanized production

HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif., has announced the series A precision wire-wound resistors for use in

New COMPONENTS PRODUCE MICRO-SECOND

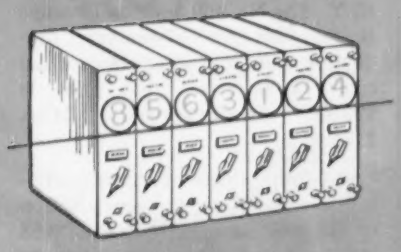
Vari-Count



Two outstanding basic electron components . . . Haydu's "Beam Switching Tube" and "Nixie" the numerical indicator tube . . . are combined to make possible this *versatile* new instrument.

- **VARI-COUNT**
  - Static to megacycle counter distributor
  - Microsecond electronic preset
  - Microsecond variable scale output
  - Microsecond recycling
  - Microsecond clearing
  - Preset gating
- **BEAM SWITCHING TUBE** (6700)
  - Replaces 20 Tubes
  - Megacycle counting 0-9
  - Megacycle preset
  - Low power consumption
  - Electronics most reliable distributor
  - Pentode "working" output
- **NIXIE** (HB106)
  - 1" x 1"
  - 10 digit 0-9 gas indicator tube
  - "Two-dimensional"
  - In-line readout
  - Common anode prebiasing
  - Low power

Write for complete technical data to:



Large, in-line numbers assure quick, accurate readings

HAYDU

BROTHERS OF NEW JERSEY

PLAINFIELD, NEW JERSEY

SUBSIDIARY OF BURROUGHS CORPORATION

THERMOSTATIC

DELAY RELAYS

Provide delays ranging from 2 to 150 SECONDS

AMPERITE

STANDARD

MOST COMPACT
MOST ECONOMICAL
HERMETICALLY SEALED

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only*—normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to + 70°C. Heaters consume approximately 2 W. and may be operated continuously.

The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive! TYPES:* Standard Radio Octal, and 9-Pin Miniature.

MINIATURE

PROBLEM? Send for Bulletin No. TR-81

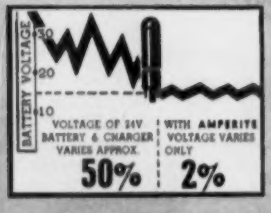
Also—a new line of **Amperite Differential Relays** — may be used for *automatic overload, over-voltage, under-voltage* or *under-current protection.*

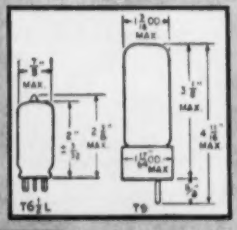
BALLAST REGULATORS

T9 BULB

- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., or Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.





AMPERITE CO., Inc.

561 Broadway, New York 12, N. Y.

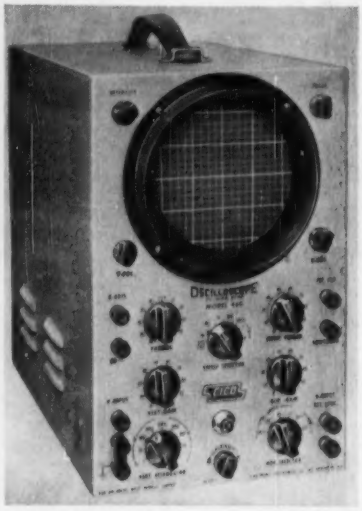
In Canada: Atlas Radio Corp., Ltd., 560 King St., W., Toronto 2B

Write for 4-page Technical Bulletin No. AB-51

printed wiring circuits. They are designed to conform to specifications proposed by RETMA for components to be used in automatic assembly equipment.

► **Encapsulation**—The resistors are encapsulated in a tough epoxy compound for protection against extreme humidity, mechanical and thermal shock. The plastic is filled with heat-conducting mineral which dissipates the heat and equalizes hot spots in winding. Sealed-in terminal connections are welded. They satisfy military requirements of MIL-R-93A and JAN-R-93.

► **Specifications**—Temperature coefficient is ±0.0022 percent per deg C; operating temperature, —65 C to + 125 C; wattage range, from 0.25 w to 1 w with tolerances to 0.1 percent.



FIVE-MC OSCILLOSCOPE for lab and production line

EICO, 84 Withers St., Brooklyn 11, N. Y. The No. 460 5-mc oscilloscope is designed for laboratory, production line, and monochrome and color tv servicing. Kit price is $79.95; factory-wired price, $129.50.

► **Features**—Some of its outstanding features include: reproduction of the 3.58 mc sync burst and 3.58 mc oscillator signals in color tv sets; flat from d-c to 4.5 mc, usable to above 5 mc; built-in voltage calibrator; vertical amplifier push-

. . . what we mean is a promotion package of 12 REGULAR ISSUES OF ELECTRONICS plus the BUYERS' GUIDE

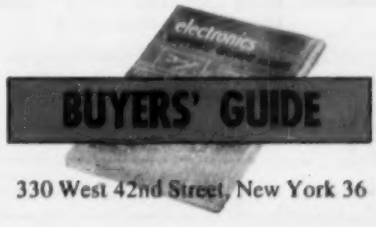
Whatever other dilemma the advertising budget planner may be in, he is in agreement on one salient point: *advertising, to develop maximum effectiveness, must be continuous.* Nothing, absolutely nothing, pays off on the long run more than getting potential buyers familiar with your product and trade name by way of consistent, all-the-year-'round advertising. Once ascertaining what your market is, the logical approach is to keep your product in view of this market through continuous, consistent advertising.

For instance, the value of continuity in advertising was demonstrated by a series of surveys conducted by McGraw-Hill's Research Department. It was found through the results of these surveys that continuity in advertising increased the recognition of an electronic firm's products 26% in nineteen months.

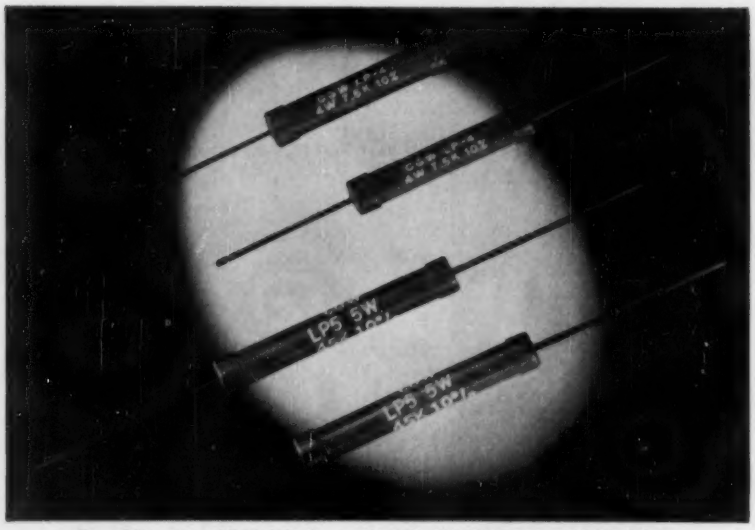
For the budget planner with an electronic account, there is a ready-made promotion package for the consistent, continuous year 'round advertising program. That program is 12 regular issues of ELECTRONICS plus the 1 issue of the ELECTRONICS BUYERS' GUIDE . . . 13 insertions for 1956! Here you will reach more than 40,000 subscribers who *pay* to get ELECTRONICS – owners, partners, corporate officers, managers, department heads, chief engineers and especially: electronic, electrical, design and research engineers; in brief, the people of the industry who are responsible for buying the products you promote in the sales pages of ELECTRONICS and the buying reference pages of the "Guide." With a consistent, continuous advertising program in 13 issues of ELECTRONICS (12 regular issues plus the "Guide") manufacturers have discovered that they get the greatest return from their advertising dollar investment because ELECTRONICS reaches the men who influence purchasing.

BUDGET NOW FOR 13 INSERTIONS IN '56!

A McGraw-Hill Publication



330 West 42nd Street, New York 36



Types LP4—4W. and LP5—5W. shown. Also LP3—3W., LP7—7W. and LP10—10W.

Corning Low-Power Resistors *for Radio and TV*

You'll find that Corning Low-Power Resistors perform admirably under the most adverse radio and TV operating conditions. Their resistance range is the highest of any low-power resistor.

Small and compact, they save space. They are non-inductive and exceptionally stable.

The fired-in film of metallic oxides on glass forms is tough, abrasion-resistant, difficult to scratch. No need for special handling to prevent damage during installation.

The automatic resistance spiralling of these LP-type resistors is electronically controlled. Press-fitted caps with axial tinned leads ready to solder complete the assembly. This guarantees reliable uniformity of the following characteristics.

CHARACTERISTICS

Range—LP3 resistors are available from 200 to 20,000Ω; LP4 from 200 to 40,000Ω; LP5 from 200 to 45,000Ω; LP7 from 200 to 36,000Ω; LP10 from 200 to 50,000Ω; with a ±10% tolerance.

Power Rating is based on 40° C. ambient temperature for the LP3, LP4 and LP5 resistors and 25° C. ambient for the LP7 and LP10 with an average hot spot of 275° C.

Derating—With suitable derating, resistors can be operated at ambient temperatures over 120° C.

Overload—Operated at 10 times the rated wattage for 5 seconds, resistance change is less than 2%.

Soldering—Permanent change in resistance due to normal soldering technique is less than ½%.

Moisture—Resistance change is less than 1% after 100 hours at an ambient temperature of 40° C. and 95% relative humidity.

At Radio Frequencies—The LP resistors are essentially non-inductive.

Mechanical Protection—A high temperature lacquer coating provides added protection during handling.

Availability—Immediately . . . through Corning Glass Works or authorized distributors of Erie Resistor Corp. For new low prices and other information send the coupon, or write to Corning Glass Works, Corning, New York.

Corning means research in Glass

CORNING GLASS WORKS
36-12 CRYSTAL STREET, CORNING, NEW YORK
New Products Division

Please send me descriptive catalog sheet on Corning Low-Power Resistors.

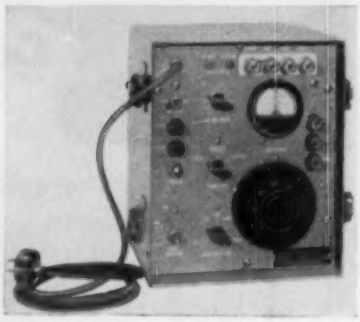
Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

pull throughout for reduced distortion, and choice of direct or capacitive coupling; 25 mv per in. vertical sensitivity; and full d-c horizontal and vertical positioning.



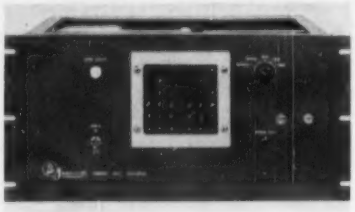
MEGOHM BRIDGE
uses encapsulated networks

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model 750 megohm bridge is a portable self-contained instrument for measuring resistance values to 1 million megohms. It contains a specially designed highly sensitive electronic detector and galvanometer for null indications. Overall accuracy is better than 2 percent of scale reading.

►**Uses**—Model 750 is designed to measure resistances, voltage coefficient of resistors, insulation resistances of transformers, and resistances of three terminal networks.

A special feature of the construction is the use of encapsulated networks to assure maximum stability of components.

Price is $550.



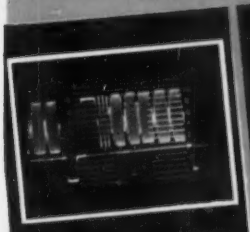
CONVERTER
card data into analog form

LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif. Model 250 punched card converter is an automatic data processing accessory that

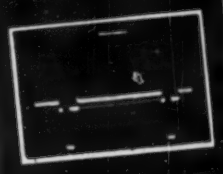
THESE SIGNALS & UNITS IN USE BY ALL MAJOR NETWORKS, STATIONS & TRANSMISSION LINKS

THE ONLY COMPLETE LINE OF VIDEO TRANSMISSION TEST EQUIPMENT

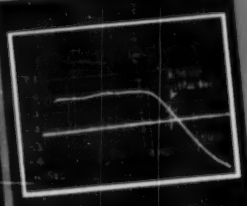
TELECHROME INCORPORATED



AMPLITUDE vs FREQUENCY. Check wide band coaxial cables, micro-wave links, individual units and complete TV systems for frequency response characteristics without point to point checking or sweep generator—Model 1070-BR.

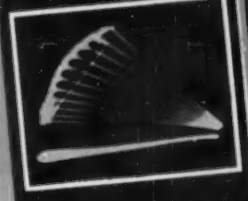


LOW & HIGH FREQUENCY CHARACTERISTICS. Determine ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.—1071-AR thru 1070-BR or 1072-AR alone.



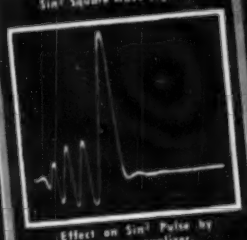
ENVELOPE DELAY vs FREQUENCY. Shown: envelope delay characteristics of Model 620 BR NTSC receiver equalizer as indicated by Model 1603-AR.

Measures "funny paper" effect.



DIFFERENTIAL PHASE vs. AMPLITUDE. Check for ability of system to transmit color with fidelity at varying amplitudes. Shown is 6AC7 video amplifier with 4° differential phase. Model 1044-AR or 1041-BR plus 1070-BR with 1601-AR.

Sin² Square Wave Signal.



Effect on Sin² Pulse by NTSC phase equalizer.

Check for transient response of a unit or system—Model 1073-A.

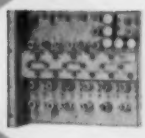
STAIRCASE SIGNAL—MODEL 1044-AR OR MODULATED—1041-BR THRU 1070-BRM

(ABOVE)—STAIRCASE SIGNAL—THROUGH HIGH PASS FILTER

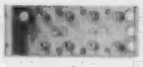
(ABOVE)—STAIRCASE SIGNAL—THROUGH LOW PASS FILTER

Hi-Lo Cross Filter for Signal analysis—608-A.

1041-BR STAIR STEP GENERATOR—Checks amplitude linearity, differential amplitude linearity and differential phase of unit or system. Variable 4-15 steps. 1044-AR—above with built in sync and blanking adder and 3.58 mc adder for modulating steps & burst on back porch.



1070-BR MULTI-BURST GENERATOR—Provides white bar and 6 bursts of pre-set freq. 0.5-6.0 mc. Own sync and blanking adder. Checks freq. response of complete system incl. those using keyed clamps. Used to add sync and blanking to output of other units (window and step generators). 1070-BRM has own 3.58 mc adder.



1071-AR WINDOW GENERATOR—Checks low frequency response of system. Fast rise time leading edge checks high frequency response. Output may be displayed on kinescope or oscilloscope. 1072-AR includes sync blanking adder.

608-A HI-LO CROSS FILTER with 3 pos. switch for viewing signal directly, or thru low or high pass filter. Allows individual observation of either high or low freq. component of signal or signal directly. Sensitive check of diff. amplitude distortion using modulated step signal from (1044-AR) through high pass section.

1603-AR PHASE SLOPE (ENVELOPE DELAY) CURVE TRACER—Instantaneous scope or meter reading of the envelope delay and amplitude characteristics vs. frequency of any network, video amplifier, or system up to 8 mc. Precise, time saving. Has separate transmitter and receiver units which allow one way or loop measurements.

1601-AR CHROMASCOPE—For accurate checking of color signals, or simultaneous amplitude and phase characteristics of a signal also used for measurement of phase and differential phase.

1521-A OSCILLOSCOPE CAMERA—Polaroid type for instantaneous 1 to 1 ratio photo-recording from any 5" oscilloscope.

1073-A SIN²-SQUARE WAVE GENERATOR—Closely equivalent to actual camera signal. Used for rapid checking of frequency and phase characteristics of a TV or pulse unit or system. Simultaneously shows amplitude, phase, and envelope delay. (Described by R. C. Kennedy, N.B.C., in "Electronics.")

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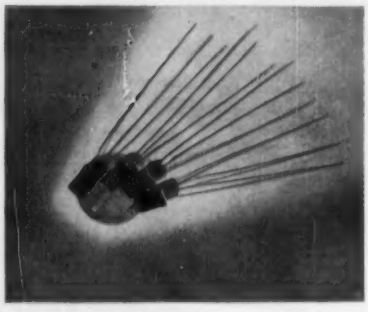
translates the decimal code punched into cards into an analog signal for automatic point plotting by X-Y plotter and recorder model 200-A.

▶**Accuracy**—The punched card converter has an accuracy of 0.1 percent when used alone and an accuracy of 0.25 when used in conjunction with a plotter.

When used with the Librascope X-Y plotter the instrument will plot approximately 60 cards per minute. Used with the IBM 523 punch machine, cards are simply loaded into the hopper, no special panel connections being necessary.

Individual punched cards may be read separately on a visual display located on the front panel of the instrument. The chart scale of the converter can be expanded independently by a factor of 10 to 1 for special data process applications.

Current price of the instrument is $2,450.



GERMANIUM TRANSISTOR
in much smaller size

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces four new transistors which are ¼ to ⅛ the size of former units. These *pnp* fused junction germanium transistors have a volume of only 0.0087 cu in. and are designated types 2N130, 2N131, 2N132 and 2N133. The first three are intended for use in audio or low r-f applications; the fourth is a low-noise transistor for use in low-level audio circuits.

▶**Noise Factor**—Average noise factor of the 2N133 is 6.5 db and will not exceed a maximum limit of 10 db. This is an improvement over the older type 2N106/CK727,

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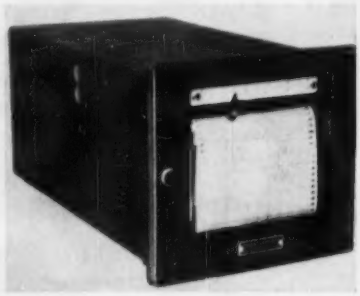
West Coast Office: 117 E. Providencia, Burbank, Calif. • Export Sales: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

now discontinued, which had a maximum noise factor of 12 db.

Maximum ambient temperature is 85 C. These transistors are electrically similar to and are designed to replace the CK731 series. Technical catalog sheets are available.



RECORDING POT
with thermocouple calibrations

WESTRONICS, INC., 3605 McCart St., Fort Worth, Texas, has announced a miniature strip-chart recording potentiometer weighing less than 25 lb. It is available with standard charts and ranges for copper-Constantan, iron-Constantan and Chromel-Alumel thermocouples, and has internal cold-junction compensation.

This recorder, of the null-balance potentiometer type, records on a 5-in. strip chart, with a pen speed of 1 sec full scale and an accuracy of better than 0.5 percent.

▶ **Prices**—The standard recorder with single speed chart drive is $425. Manual change gears to provide three speeds are optional with single-speed instruments for $15. The three speed, quick change, gear shift chart drive feature is $50.

▶ **Special Features**—Backset Micro Switches for alarm or auxiliary control, additional chart speeds, other than standard ranges and transmitting slidewires are some of the special features which can be incorporated in the recorder.

POTENTIOMETER
for 50 to 70,000-ohm range

FAIRCHILD CONTROLS CORP., Hicksville, L. I., N. Y. Type 747-E potentiometer provides a resistance range of 50 to 70,000 ohms with a standard linearity of ±0.15

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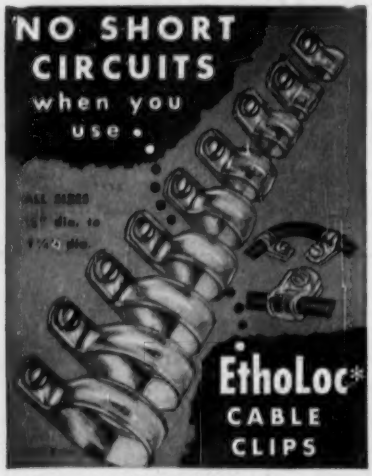

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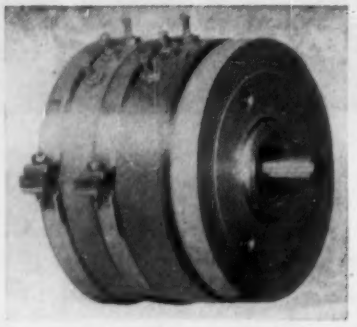
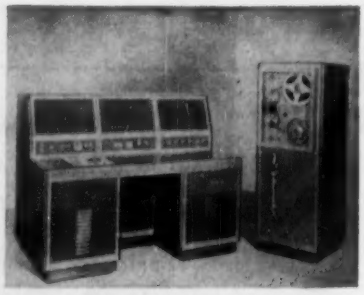


percent. A special clamp provides an unrestricted tapping area allowing up to 19 taps and presents a simplified means of phasing units in a ganged assembly without disassembling the units.

▶ Uses—The low noise level and high resolution of these units make them particularly desirable for computer assemblies, calibration controls, servomechanisms and other similar applications.

Type 747-E has a diameter of 2.100 in. and a cup width of 0.984 in. and up to 6 units can be ganged on a single shaft. The units are furnished with welded taps and end leads. Low starting torque is only 1.0 oz-in. per cup section.

Prices range from $30 to $40 a cup in sample quantities; $15 to $25 a cup in production quantities.



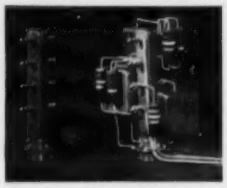
CONVERTER
analog-to-digital type

J. B. REA CO., INC., 1723 Cloverfield Blvd., Santa Monica, Calif., has available a high-speed, accurate analog-to-digital converter with capacity of up to 100,000 conversions per sec, 30 mv resolution and 0.1 percent guaranteed accuracy. It will accept signals from transducers, f-m discriminators, f-m or pwm magnetic tapes, film

for that short grid lead use the Sangamo

Tote-m-pole

First used in Navy electronic gear, Tote-m-poles are invaluable for "bug-resistant" wiring of models and production units. Advantages: Short leads; high component density; improved ventilation.



Tote-m-pole supporting "T" network of 5 resistors and 4 capacitors.

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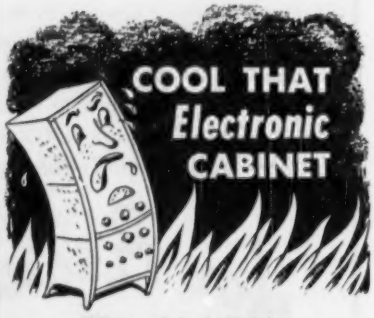

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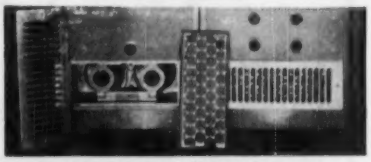

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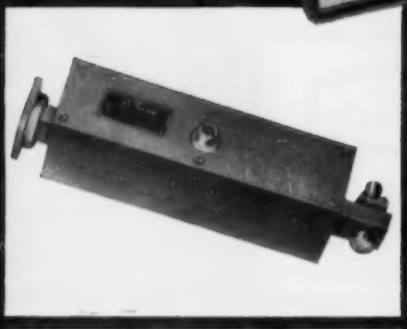

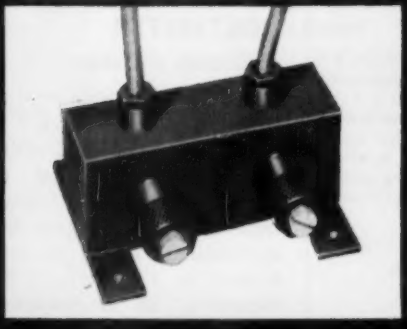

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Insertion Loss (For 1% bandwidth)	≤1.5 db	≤1. db	≤1. db	≤1. db
Rejection ($F_0 \pm 2xBW$) (db)	24 36 48	24 36 48	24 36 48	24 36 48
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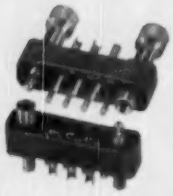
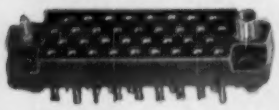


SM-7
7 Contacts
ACTUAL SIZE



SM-34 with hood
34 Contacts
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Polarizing screwlocks eliminate the need for prying, "rocking" or forcing the connector when disconnecting the plug from the receptacle. They provide absolute protection against accidental separation of the plug and receptacle.

From the tiny 7-contact (illustrated above, right) to connectors accommodating as many as 50 leads of #20 AWG wire, Continental can provide you with precision-made subminiatures for any project. The screwlock feature is also available in a variety of larger connectors, including miniature, hermetic seal, and high voltage.

These screwlocks were developed to provide vibration-proof connectors for critical armed services equipment.

Technical data on these connectors, and special designs requiring the use of subminiature, printed circuit, hermetic seal, pressurized, high voltage, or power connectors, are available on request. Write today for complete catalog.

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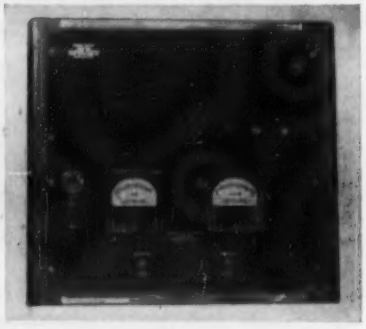
readers or other analog sources, and convert them to any desired digital code.

▶ **Sampling**—Used with appropriate commutating, it will sample, in sequence, data from any number of analog sources. Digital output may be printed out, or used as input to a digital computer. Interim storage of the digital data can be accomplished, if desired, by a programmed magnetic tape unit.

▶ **Price**—The basic converter price is $12,000, with the price adjustable depending on the speed required by the application. The price of a complete conversion system varies of course with the extent of the requirements of each individual application.

A Rea high-speed input commutation switch, digital output magnetic recorders and programming circuits are among the new features offered in complete converter systems. An 8-page illustrated brochure is offered.



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FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Type 1560 differential voltmeter is extremely useful when checking response and attenuation of filters, transformers, amplifiers and other applications where a small difference in two voltages is to be measured, as it measures differences in voltage levels as low as 0.01 percent regardless of their relations.

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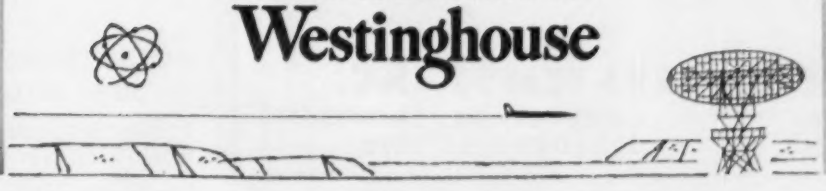

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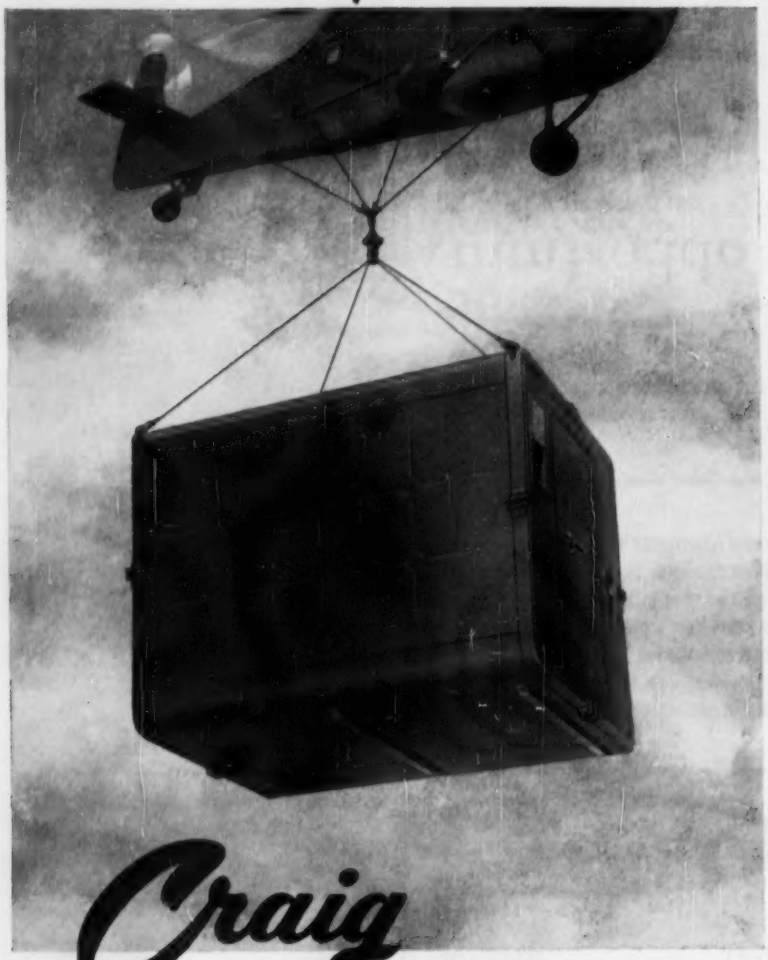

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▶**Specifications**—Difference voltage range is −10 percent to +5 percent in 0.01 percent increments. Input voltage levels are from 0.1 v to 100 v. Frequency range is 30 cps to 20 kc. Input impedance is 500,000 ohms. The instrument is entirely self-contained and operates from a 115-v, 60-cycle line.

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is fully transistorized

UNIVERSAL ATOMICS CORP., 19 E. 48th St., New York 17, N. Y., has available the fully transistorized gamma gun, a self-contained, hand-portable scintillation counter giving 500,000 counts per minute—300 time as sensitive as a single Geiger tube. It has a 2¼ in. sodium iodide crystal, a built-in preamplifier and a full-view ore evaluation meter.

▶**Uses**—The gamma gun is designed for use both on the ground and in the air. Its light weight and small area permit it to be used comfortably in the smallest plane.

It has six operating ranges to give maximum sensitivity and four time constants ranging from 1 to 60 seconds. The use of transistors in combination with mercury cells completely eliminates drift.

The gamma gun will operate for over 1,000 hours of continuous field use with no battery charges. It sells for $995.

POTENTIOMETER
for 80 to 150,000 ohms

FAIRCHILD CONTROLS CORP., Hicksville, N. Y. Type 748-E potentiom-

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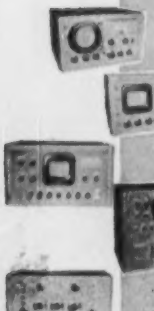
Shown here are just a few of the many instruments Panoramic has designed to meet your needs for rapid, yet accurate analysis and measurement. Send for Panoramic's Catalog and find out how Panoramic can give you the right answer to your research, development and production problems. Our specialists are available for consultation, without obligation.



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eter offers a high degree of accuracy in a resistance range of 80 to 150,000 ohms.

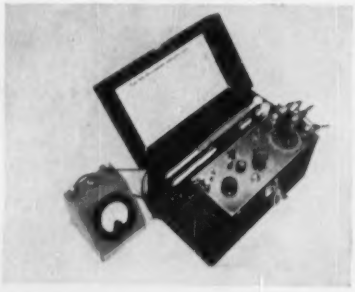
▶ **Linearity**—Standard linearity tolerance for the potentiometer is ±0.10 percent. On special order linearity up to ±0.05 percent can be obtained on higher resolution windings.

Low starting torque is only 1.0 oz-in. per cup.

▶ **Tapping Area**—A special clamp-band feature provides an unrestricted tapping area allowing up to 33 taps and presents a simplified means of phasing units in a ganged assembly without disassembling the units. The unit is furnished with welded taps and leads.

The potentiometer is gangable in assemblies of up to 6 cup units on a single shaft. It has a diameter of 3⅛ in. maximum and a cup width of 0.984 in.

Prices range from $30 to $40 a cup in sample quantities; $15 to $25 a cup in production quantities.



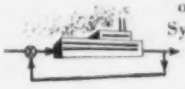
GROUNDOMETER is completely portable

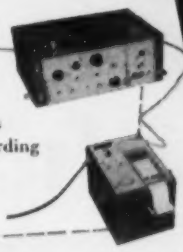
BORDEN ENGINEERING CO., Division of M. J. Johnson Aircraft Engineering Co., 39 E. Hanover Ave., Morris Plains, N. J. The new type W4 Groundometer is a null-reading Wheatstone bridge for measuring the resistance to ground of driven

SANBORN
OSCILLOGRAPHIC RECORDING SYSTEMS

"ON THE JOB"
PROVIDE VALUABLE DYNAMIC ANALYSIS DATA

PRODUCTION TESTING
of components is accomplished by a Servo Component manufacturer by means of a Sanborn Single-Channel Recording System with a Sanborn Servo Monitor Preamplifier.





Sanborn Single-Channel System

DYNAMIC PERFORMANCE
of valves when equipped with a certain pneumatic Valve Positioner is determined by the manufacturer with a Sanborn Two-Channel System and Sanborn Carrier Amplifiers.

Sanborn Two-Channel System

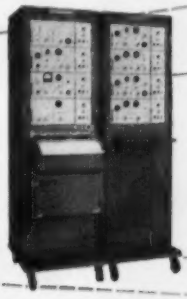
ACCELERATION and TORQUE
are recorded simultaneously by an oil company in their study of fuels and lubricants as they relate to engine performance.

DRONE MISSILE
manufacturer can simulate the flight of the missile and derive information concerning its behavior under certain conditions by means of an analog computer and a Sanborn Four-Channel System with four Sanborn AC-DC Preamplifiers.

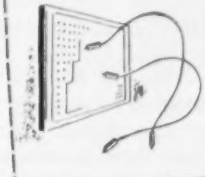
Sanborn Four-Channel System

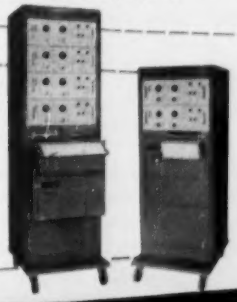
ATOMIC REACTOR
to be used for power generation in prototype plant is studied with the help of a Sanborn Eight-Channel System which records the output of thermo-couples, strain gage pressure pickups, and resistance devices.

Sanborn Eight-Channel System



ANALOG COMPUTING
center uses Sanborn Eight-Channel Systems to record the solutions of problems having six or eight variables. Sanborn systems specially designed for this type of work utilize Dual-Channel DC Amplifiers.





A new 16-page Catalog fully describes Sanborn "150" Series Systems, Components and Accessories. Copies on request.

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Preamplifier Interchangeability
Eleven Types of Preamplifiers
Improved Over-all Linearity
Accessibility of Chart During Recording

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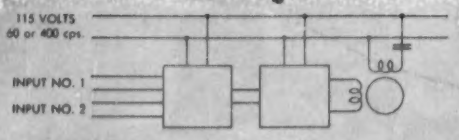
MINIATURE
SERVO
Magnetic Amplifiers

Three New AC Servo Types Available..



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In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

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— we design and engineer complete servo or automatic control systems

● MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS
Supply: 115 volt 400 cps.
Power output: 3.5, 6, 10, 18 watts
Sensitivity: 1 volt AC
Response Time: .03 sec.
Lowest Cost — Smallest Size
For further information request Form S493

● MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER
Supply: 115 volt 400 cps.
Power output: 5, 10, 15, 20 watts
Sensitivity: .1 volt AC
Response Time: .008 to .1 sec.
Highest performance — All magnetic
For further information request Form S496

● TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER
Supply: 115 volt 400 or 60 cps.
Power output: 2, 5, 10, 15, 20 watts
Sensitivity: .08 volt AC into 10,000 ohms
Response Time: .01 sec.
Fast response at high gain
For further information request Form S499 (400 cps.); Form S497 (60 cps.)
*TRADE NAME

AFFILIATE OF THE GENERAL CERAMICS CORPORATION

MAGNETIC AMPLIFIERS • INC
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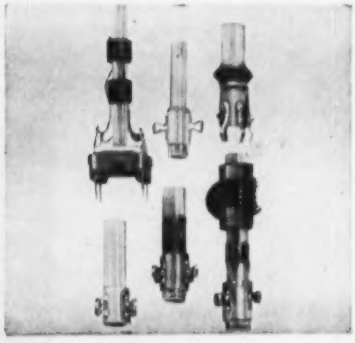
ground rods, transmission line towers, radio and tv antenna grounds and industrial plant grounds. It has full scale ranges of 1-5-10-50-100-500-1,000-5,000 and 10,000 ohms.

The instrument has, in its portable carrying case, a compartment for all the necessary reference rods and test leads, which are of the proper lengths to serve as measuring lines for the correct reference electrode spacing. Due to its patented circuit, only the 10-in. reference rods need be used and the Y-reference electrode may be as high as 400 times the resistance of the ground being measured.

▶ **Other Use**—The W4 can also be used as a d-c Wheatstone bridge from 0.01 ohm to 100,000 ohms at 0.1 percent accuracy by connecting an exterior d-c galvanometer.

The complete instrument is 7½ in. by 7½ in. by 12 in. and weighs only 16 lb. Price is $160 plus $25 for the galvanometer if it is desired.



COIL FORMS
less production time, costs

RADIO INDUSTRIES, INC., 5225 Ravenswood Ave., Chicago 40, Ill. New, one-piece coil forms reduce coil production time and costs by eliminating the need for mounting clips and minimize the number of assembly operatons.

RI-l on precision molded forms of high temperature plastic are being used in the manufacture of RI-tran transformers and coils for countless r-f applications.

The RI-l form construction is used in both conventional and printed-circuit type applications and is available in a variety of colors for easy identification. RI-tran

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"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

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Mumetal shields will give instant relief to interference caused by extraneous magnetic fields. This material can cure many troubles—solve many a problem for you.

Use it where high permeability is required at low flux densities, such as in input and microphone transformers, hearing aid diaphragms, instruments, wire and tape recorders, etc. For properly heat treating Mumetal, we can also offer commercial hydrogen annealing facilities.

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In addition to Mumetal and other high-permeability alloys, we offer a range of magnetic and electrical alloys and steels that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment. ● Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

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WAD 5279

AL STEELS FOR THE ELECTRONIC AGE

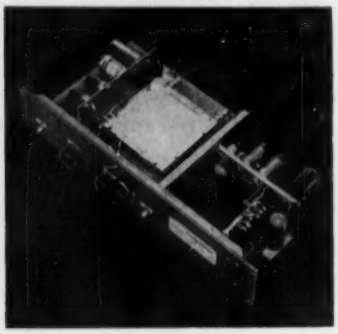
transformers are available in 8-32 or ¼-28 RI-lon tube construction.

► **Design**—A new snap-in keyed design eliminates the need for mounting clips, but is interchangeable with clip-mounting chassis cut out. RI-lon one-piece forms resist electrolysis indefinitely, have uniform characteristics and simplify components for automatic insertion in printed-circuit type applications.

RESISTORS
are deposited carbon type

DALE PRODUCTS, INC., Columbus, Neb. The Dalohm deposited carbon resistors are now being supplied with an improved coating material. The material incorporates such features as extreme toughness for rough handling; low temperature cycling (to −85 C); resistance to humidity, and high-temperature characteristics, making these resistors suitable for printed circuit solder dipping without the added space required for sleeving.

Identified as types DC (per Spec MIL-R-10509A) and CC (commercial grade), Dalohm deposited carbon resistors are available in 8 standard sizes from ½ w to 5 w, and resistance range to 500 megohms. Standard tolerance is 1 percent.



DELAY CHANNEL
available as complete unit

STURRUP, INC., Middletown, Conn., has announced the model 500 ultrasonic delay system available as a complete unit. The unit includes a compact solid ultrasonic delay line with predelay and post-delay circuits, and a self-contained, regulated power supply, particularly suiting it for radar, computer and

marion new MEDALIST* meters

advancement in instrument design

Greater readability and modern styling in minimum space. Interchangeable with ASA/JAN 2½ and 3½ inch sizes. Up to 50% longer scale in same space as ordinary type. Available in various colors. Complete data on request.

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The correct wire to correct terminal every time!

Connections are made through Fanning Strip, on bench or anywhere apart from barrier strip, and quickly slipped into assembly.

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Just press the easy-acting lever on this Quick-Reset Ratchet Counter . . . *and all 4 figures reset to zero as instantly as though you used a push-button.* This saves time and speeds work on short machine runs, inspection and many other jobs. Counter is compact . . . 2.69" long, 1.44" high, 1.29" wide. The 4 white-on-black figures are .166" high. You can order it (Series 1126) from stock right now . . . just like scores of other Veeder-Root Counters for manual, mechanical and electrical operation in every field from electronics to atomics.

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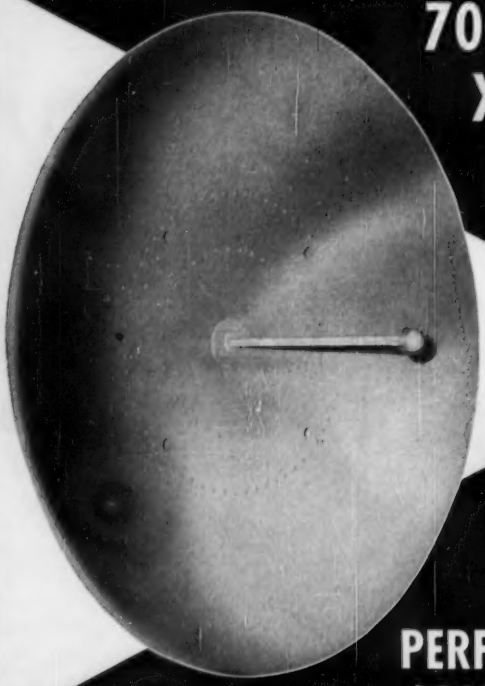

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For every microwave application, Gabriel can furnish antenna equipment of proved efficiency and reliability. The experience and facilities of Gabriel Laboratories offer prompt, dependable solution of your antenna problems. And the manufacturing plant of Gabriel Electronics Division assures volume production *to the Laboratories' performance specifications.*

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GABRIEL ELECTRONICS DIVISION
THE GABRIEL COMPANY, Needham Heights 94, Massachusetts

autocorrelation systems as well as general laboratory use.

▶ **Specifications**—The unit illustrated has a delay of 500 μsec ±5 percent. Characteristics include a video response of −3 db between 10 cps and 4.5 mc and a signal-to-noise ratio of 40 db. Several units may be cascaded for longer delays.

VARNISH
for printed circuits

THE INSL-X SALES CO., 26 Rittenhouse Place, Ardmore, Pa. A new varnish designed especially as a protective insulating coating for modular assemblies, printed circuits and printed circuit components has been developed by the Schenectady Varnish Co.

▶ **Complete Sealing**—Far more flexible than conventional coatings, the Schenectady No. 642 printed-circuit varnish can be baked or air-dried to a tough resilient coating that completely seals the laminate and component leads against arc-producing moisture. A 2½ mil coating of this water-white varnish withstands 1,250-v—even after 72 hours exposure at 100 percent relative humidity.

▶ **Other Features**—The highly arc-resistant varnish will not support tracking, nor will it char. It is completely free from aging characteristics or discoloring and may be readily thinned with Xylol or its equivalent.

ECHO BOX
tests airborne radar

THE NARDA CORP., 66 Main St., Mineola, N. Y. Model 833 echo box is a high Q resonant cavity, specifically designed for rapid test-

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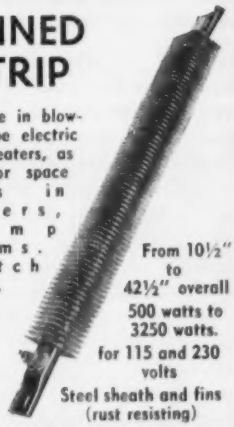
ELECTRIC HEATING UNITS

FINNED STRIP

For use in blower type electric unit heaters, as oven or space heaters in dryers, pump rooms, switch towers, etc.



From 10½" to 42½" overall
500 watts to 3250 watts.
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Steel sheath and fins (rust resisting)

For use where sheath temperature will not exceed 750° F.

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Ferroxcube shielding beads on input leads provide simple, efficient decoupling so that h-f, i-f and pulse signals from output stages will not be picked up by input wiring. High-permeability Ferroxcube material increases inductance so that lead acts as h-f choke while l-f, h-f and pulse oscillations are damped by high losses that occur in Ferroxcube 3B at frequencies over 0.5 mc.

Ferroxcube shielding beads also increase the h-f effectiveness of button-type ceramic feed-thru capacitors.

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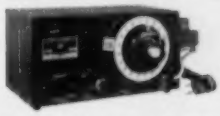
Measure frequency and FM deviation on a multitude of channels with just two small LAMPKIN METERS



LAMPKIN 105-B MICROMETER FREQUENCY METER—Heterodyne-type, universal coverage, 0.1 to 500 MC. Accuracy 0.005%. Weight 13 lbs. Width 13". Price $220.00.

LAMPKIN 205-A FM MODULATION METER—Indicates FM voice deviation, ± 25 KC., all channels, 25 to 500 MC.; meets FCC mobile specs. Weight 13 lbs. Width 12¼". Price $240.00.

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30.0 mfd in less than 0.03 cu. in.

The tantalum oxide film employed in Fansteel Capacitors is the most stable dielectric, chemically and electrically, yet discovered. Fansteel Tantalum Capacitors have a practically unlimited life, either in use or on the shelf; have a maximum d-c leakage of only 0.000008 Ampere; and stable characteristics are unchanged over a wide temperature range.

Fansteel offers Tantalum Capacitors in 58 sizes and ratings. A partial listing is shown here. All sizes are available from stock.

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CATALOG NUMBER	CAPACITY MFD*	WORKING VOLTAGE D-C	MAXIMUM D-C LEAKAGE§
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FP2585A1	25	8	1.0
FP2081QA1	20	10	1.0
FP1581SA1	15	15	1.5
FP1082SA1	10	25	2.0
FP8830A1	8	30	2.0
FP5850A1	6	50	3.0
FP4080A1	4	60	3.0
FP3.5075A1	3.5	75	3.0
FP2810QA1	2	100	3.0
FP1.75125SA1	1.75	125	3.0
FP140B6A1	140	6	2.0
FP100810A1	100	10	2.0
FP70B15A1	70	15	3.0
FP40B30A1	40	30	4.0
FP25B50A1	25	50	5.0
FP20B60A1	20	60	5.0
FP15B75A1	15	75	6.0
FP11U100C1	11	100	7.0
FP9B125C1	9	125	7.0
FP325B6A1	325	6	3.0
FP250B10A1	250	10	3.0
FP175B15A1	175	15	4.0

*—15% +30% @ 120 cps, 25°C
§ Microamperes, at 25°C

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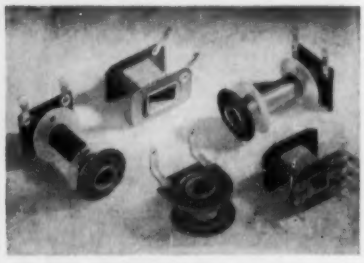
North Chicago, Illinois, U.S.A.

TANTALUM CAPACITORS . . . DEPENDABLE SINCE 1930

ing of the overall performance of C-band (5,350 to 5,450 mc) airborne weather radars. The cavity is coupled to the radar transmission line through a directional coupler or with a pickup antenna placed near the radar antenna.

▶**How It Works**—During the radar transmitted pulse, microwave energy is stored in the echo box. Immediately following the pulse, the energy is returned to the radar over the same path producing a signal or target on the radar indicator. At the end of the pulse the returned energy decays exponentially, finally disappearing into the background noise clutter at a point determined by the receiver sensitivity and transmitter power output.

Therefore, the time interval between the beginning of the transmitted pulse and the point where the signal on the radar indicator disappears into the noise (called the ring time) measures the overall performance of the radar. Price is $970.



COIL BOBBIN
lug terminals attached

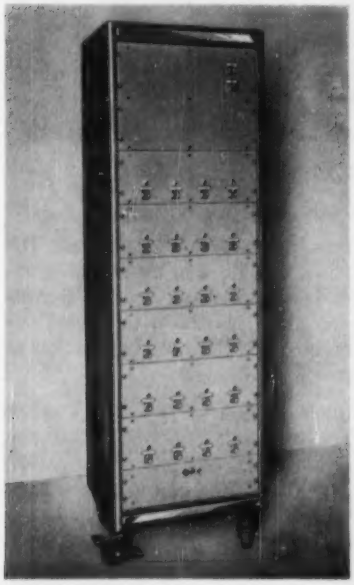
PRECISION PAPER TUBE CO., 2035 W. Charleston St., Chicago 47, Ill., can supply coil bobbins with any desired number of lug terminals attached. The attached lug feature perfectly adapts the bobbins for use with printed circuits.

▶**Another Advantage**—These coil bobbins can be insulated from the coil winding by washers as an integral part of the assembly. This not only improves insulation, but it greatly facilitates easier and faster production of the finished coil.

Bobbins are available in any size with round, square or rectangular core, and flanges of all shapes. Cores are wound from dielectric

kraft, fish paper, acetate or combinations, including DuPont Mylar. They can also be supplied Resinite impregnated.

Since the bobbins are made to order, cost will be affected by such factors as specifications, the number of lugs attached and the time element involved in making them.



DATA REDUCER
shows vibration frequencies

HYCOR CO., INC., 11423 Vanowen St., N. Hollywood, Calif., announces a data reduction filter set for analyzing vibration frequencies in aircraft and missiles. In use, a tape recorder containing the complex wave form is fed into the unit which separates the component frequencies into 24 components.

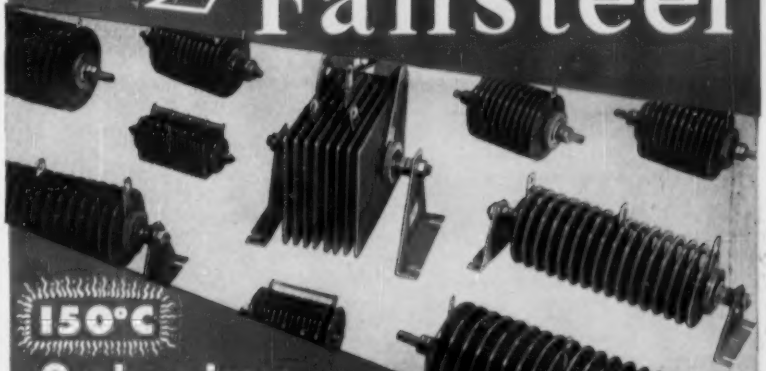
▶ **Cathode-Follower Amplifiers**—The unit consists of 24 cathode-follower amplifiers which feed 23 band-pass filters ranging progressively from 30 cps to 2,000 cps, and one 20-cycle low-pass filter.

Output of each filter appears on jacks on the front panel. A channel-level control is provided for each filter. A set of jacks is also included on the front panel for oscilloscopic viewing of the complex waveform at the input.

The individual frequencies may be analyzed separately to determine the exact nature of the mechanical

SMALL IN SIZE . . . . BIG IN CAPACITY

Fansteel



150°C

Selenium RECTIFIERS

about ⅓ the size and ¼ the weight of a comparably rated standard rectifier

CATALOG NUMBER	CIRCUIT	INPUT A-C VOLTS	CONT. D-C OUTPUT AT 100°C VOLTS	AMPS.
TADL35L	1-35-1-H	455	402	0.006(*)
TEUH315(*)	2-8-1-D	132	254	0.020(*)
TBU100L	1-10G-1-K	2600	1080	0.020
TEB328L(*)	2-11-1-D	383	297	0.150
TEW086L	4-4-1-B	132	108	0.180
TEC070L	4-5-1-B	165	135	0.300
TEX034L	4-1-3-B	33	27.8	1.98
TED200LN	2-13-1-C-N	214	175	0.600
TBY060L	4-3-1-B	78	62.7	1.0
TBY080L	4-3-1-B	41	62.7	1.0(*)
TEEW334L(*)	2-7-1-D	231	295	2.3(*)
TEFW332L(*)	2-13-1-D	429	548	4.0(*)
TBG064L	2-1-1-C	13	10.4	5.2
TET090L	4-2-1-B	66	53.9	4.6
TEP314L(*)	2-7-2-D	231	189	14.0
TER020L	6-3-1-B	66	79.5	12.5(*)
TER034L	4-1-3-B	33	27.8	25.4
TBR008L	6-1-4-B	26	32.5	51.6(*)

(*) Capacitive load. Ratings s-marked are for resistive or inductive loads.
(*) Hermetically Sealed.
(*) Two stacks required.
(*) Three stacks required.
(*) Resistive, inductive or capacitive load.

Operating at 100°C (212°F) Fansteel High Temperature Rectifiers deliver full rated power output, continuously, with no derating whatever. At temperatures up to 150°C (302°F), only moderate derating is necessary.

Fansteel High Temperature Rectifiers are available in all standard cell sizes and all standard circuit arrangements and with all standard protective finishes—moisture resistant, fungus resistant and a salt-spray resistant finish that really works! The table indicates a partial list of over 100,000 available types.

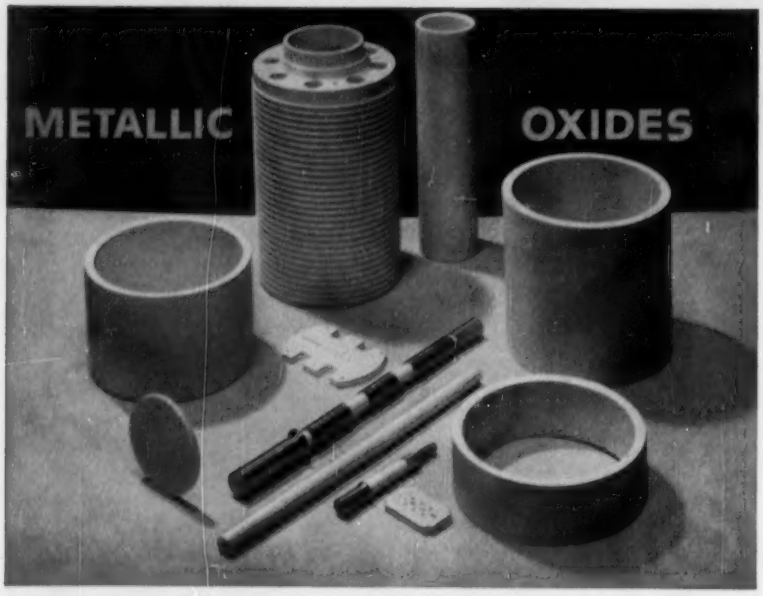
Send for bulletin 6.401

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U.S.A.

DEPENDABLE RECTIFIERS SINCE 1924

Stupakoff

ALUMINA CERAMICS



These man-made "sapphires" provide

EXTRA strength . . .
EXTRA hardness . . .
EXTRA precision . . .

For mechanical, electrical and electronic applications, Stupakoff Alumina Ceramics provide highly valuable characteristics. Because they are exceptionally hard, parts made of this material serve well under conditions of abrasion and wear. Because of the material's high strength, it finds many applications where its resistance to pressure, shock and impact adds to the life and service of an assembly. Because Stupakoff has the equipment and skill to mass-produce alumina parts with dimensions held to close tolerances, Stupakoff precision ceramics assemble readily and function correctly.

Parts may be simple or complex, ground or machined, plain, metallized or assembled. Our research and engineering facilities are available to assist in the design of your parts.

Stupakoff

Write Dept. E.

Division of The CARBORUNDUM Company

LATROBE, PENNSYLVANIA

vibration. The entire unit, including power supply, is contained in a standard enclosed 5-ft cabinet rack.

AXIAL BLOWER
is smaller and lighter

JOHN OSTER MFG. CO., Avionic Division, 1 Main St., Racine, Wisconsin, has developed a smaller, lighter 2-in. axial blower with exceptionally high air delivery in relation to volume and weight.

▶ **Performance** — Type AXB2249 puts out 25 to 30 cu ft of air per minute at zero static pressure yet weighs only 8 oz and measures only 3.375 in. long by 2.87 in. o-d. Operating temperature range is from −55 C to +71 C. Other military aircraft environmental requirements are also met.

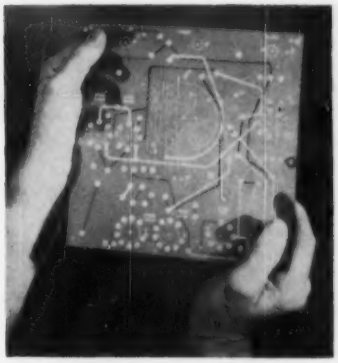
The device consists of an aluminum blower housing black anodized, a 2-in. aluminum fan and a 115-v 400-cycle motor.

Type AXB2249 is used for cooling a wide variety of electronic equipment in aircraft and industrial applications.

LAMINATED PLASTIC
for printed circuitry

THE FORMICA CO., Cincinnati 32, Ohio. The XXXP-36 Formica cold-punching laminate brings translucency, greater accuracy and superinsulation to printed circuitry. Since it punches cold in thicknesses up to and including ☆ in., no heat cycle is required. Thus the base laminate is not subject to dimensional change as in grades which must be heated before punching. Circuits made from the new grade will be more accurate.

Formica XXXP-36 also offers



high dielectric strength, greater heat resistance and superior bonding strength. Simply by holding the Formica sheet to the light it is possible to see the smooth, homogenous structure, and to note how well the circuit printed on one side registers with that on the other.

For a free sample, write the company.

INDICATOR
checks coils for shorts

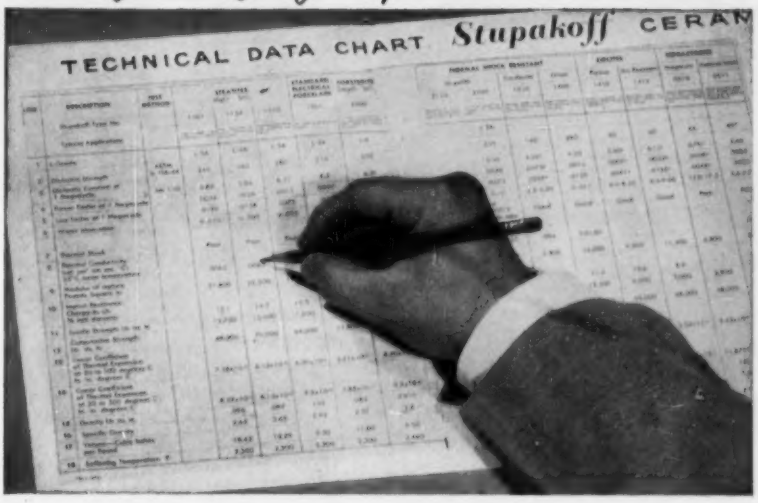
KARTRON, Drawer 472, Huntington Beach, Calif. Model 101-D electronic shorted turn indicator is sensitive, rugged and nonshocking when checking unmounted electrical coils for shorts. Mandrel size is small enough for all but the smallest coils; large enough for coils up to about a 2-in. cube outside, or equivalent volume in most other shapes.

The unit is designed to detect

Stupakoff

CERAMIC MATERIALS

At your fingertips . . .



NEW TECHNICAL DATA on *Stupakoff* CERAMIC MATERIALS

The very latest technical information on a wide range of ceramic materials is given in the new Stupakoff Technical Data Chart. Electrical and physical characteristics and the chemical composition of various grades of the following ceramic materials are included:

ALUMINA	PORCELAIN	ZIRCON
ALUMINUM SILICATE	STUPALITH	ZIRCITE
STEATITE	CORDIERITE	FORSTERITE
	MAGNESIA	

Valuable design and application suggestions included in the Stupakoff Data Chart help you engineer your ceramic parts for lowest cost and greatest satisfaction.

Send today for your free copy of the new Stupakoff Data Chart. Arranged for ready reference.

Stupakoff

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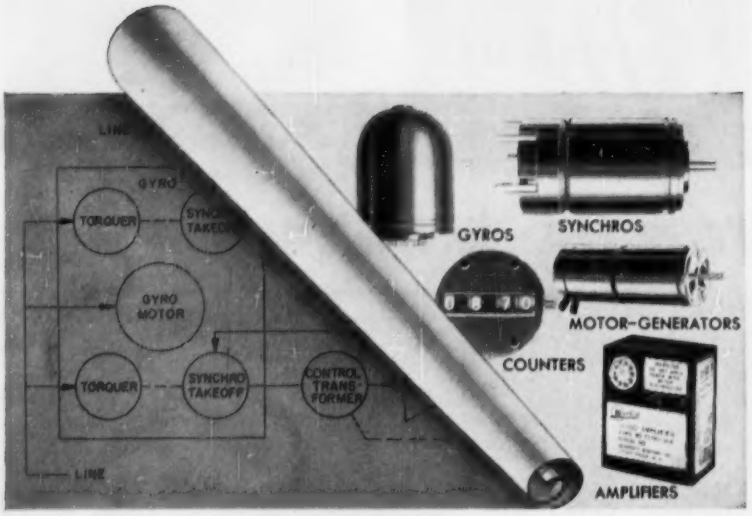


KEARFOTT
. . . from problem through production

Engineering ability and production facilities are as important to you as the characteristics of the components you select. After components are approved, you are dependent upon your supplier . . . dependent upon him for engineering assistance . . . dependent upon his ability to produce quality products in the required quantities.

Many of the servo motors, synchros, gyros and systems in use today had their inception on the drafting boards of Kearfott's engineers. This is proof of Kearfott's engineering ability. Kearfott offers complete engineering service before, during and after the purchase of a component.

Modern buildings, over 430,000 square feet of floor space, equipped with the latest in precision machinery, manned by 3,400 highly skilled specialists, are your assurance of Kearfott's ability to produce.

Yes, Kearfott is a dependable source of supply. If you have a design problem or require a special or standard component, contact Kearfott.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of components of interest to you.

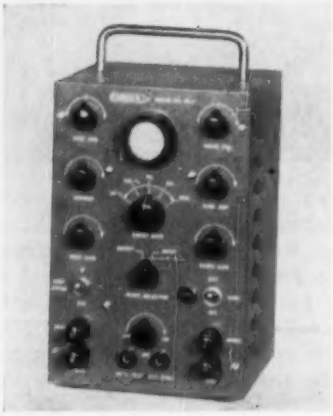
Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

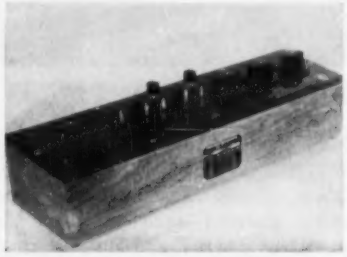
one shorted turn of No. 44 wire and built for years of production line high speed testing. Shorts are indicated on the 1-ma meter by a downward deflection ¼ to ½ full scale.



SMALL OSCILLOSCOPE weighs 8½ lb

PROBESCOPE CO., 44-05 30th Ave., Long Island City 3, N. Y., has designed a portable miniature oscilloscope weighing 8½ lb and taking up less than ¼ sq ft on the bench. It measures 9 in. high, 6 in. wide and 5 in. deep.

Model MO-1 has the following features: an input impedance of 2 megohms shunted by 15 $\mu\mu$f; a 10-to-1 attenuator; vertical sensitivity of 100 mv full scale; sweep rate of 20 cycles to 30 kc in 5 steps. It is ideal for waveform analyzing and quick troubleshooting.



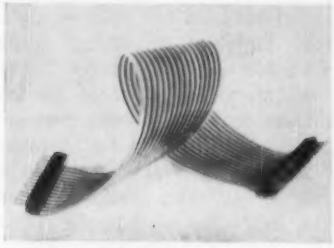
RESISTANCE DECADE has seven dials

INDUSTRIAL INSTRUMENTS, INC., Cedar Grove, N. J. A new resistance decade featuring accuracy of better than ±0.1 percent of each resistance increment is announced. The

instrument has 7 dials having decade steps of 0.1, 1, 10, 100, 1,000 10,000 and 100,000 ohms. Decades are available with each dial having 9 or 10 steps.

Resistance coils are of manganin wire, bifilar wound, with the exception of 10,000 ohms and over which are low temperature coefficient nickel-chromium-iron alloy wound. All resistance coils are wound on ceramic cores, oven-aged and varnish impregnated.

Switches are the self-cleaning type with 4 phosphor-bronze spring wipers and detent mechanism for positive location of switch points. Switches and resistors are mounted below the panel for maximum protection from dust.



FLEXIBLE CABLES
for printed circuits

SANDERS ASSOCIATES, INC., Nashua, N. H. Flexible printed circuit cables—made by a process of laminating the versatile plastic Kel-F with copper in thin sheets—are now being introduced. The new cables have excellent electrical and mechanical properties for operation over a wide range of environmental conditions.

Complete encapsulation of the conductors in Kel-F ensures maximum protection against moisture. Glass cloth can also be included in the laminations for increased strength and high temperature stability. The new lighter and thinner cables are adaptable to many types of connectors or terminations and are easily secured by clamps, rivets or cement. The manufacturing technique eliminates wiring errors.

Additional conducting and insulating layers can be added to the basic cable to provide a greater number of separate conductors. Stacked circuits have been built up

now . . . new technical data bulletin on delay lines from

EPSCO

New Technical Advances, New Materials and Techniques Have Resulted in Delay Lines of Unusual Characteristics . . . And At Low Cost:

If you use delay lines in: Telemetering — Digital or Analog Computers — Pulse Circuits — Coders and Decoders — Navigation Systems — Stable Time Reference Units — or in special applications — you'll find this brand new technical bulletin of great interest and use in your work.

CHARACTERISTICS OF NEW STANDARD* UNITS

All Standard units are *guaranteed* to have the following characteristics:

Temperature coefficient of delay less than 50 parts per million per °C.
Operating temperature range: —55C to 125C.
Delay tolerance 3%.
Spurious signals less than 5%.
Characteristic impedance tolerance 5%.
Attenuation in DB approximately 0.1 to 0.2 times delay-to-rise-time ratio.

*Custom units are built to even more stringent specifications.

CONTENTS

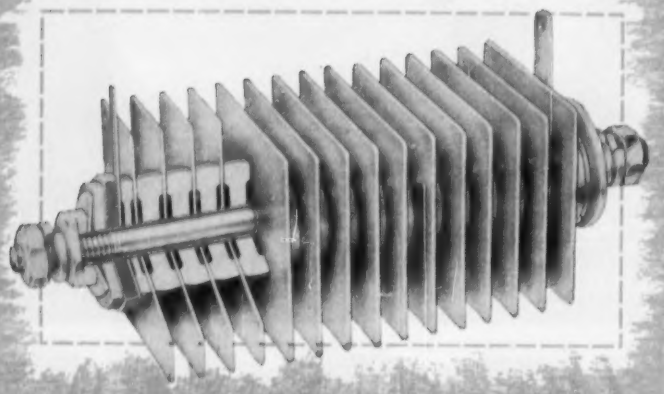
New Standard Series
Precision Audio Delay Lines
Custom Designed Units
Special Applications
Design Formulae
Typical Circuits
Characteristic Impedance
Attenuation
Delay Time
Rise Time
Delay-To-Rise-Time Ratio
Bandwidth
Phase Linearity
Spurious Signals
Operating Temperature Range

EPSCO INCORPORATED

SEND FOR BULLETIN DL-55 TODAY! 588 Commonwealth Ave., Boston, Mass.

UNION

Selenium Power Rectifiers with "Solid Stack" assembly



The "solid stack" assembly of the new line of UNION Selenium Rectifiers provides utmost rigidity and far more resistance to vibration. It eliminates radial movement and prevents breaks in the paint seal.

This extra rigidity is obtained by using larger, non-resilient spacer washers finished flat to close tolerances and all parts are under constant pressure exerted by Belleville springs at the ends of the stack.

The selenium cells are produced by a special and carefully controlled process which assures uniform high quality and better performance. Corners are rounded instead of sharp for safety, and to assure an unbroken coating. Connectors are made of brass or bronze for better service under adverse conditions.

Ratings: The standard line of UNION selenium rectifier cells range in size from 1" x 1" to 5" x 6" and with convection cooling, are rated from .180 to 10.0 amperes per cell on a single phase fullwave bridge basis. Cells can be "stacked" in series, parallel or series-parallel combinations to fit practically any current and voltage conversion requirement. The stack assemblies conform to NEMA specifications.

Write for our Bulletin 1009, or contact any of our distributors listed below for complete information.

GENERAL APPARATUS SALES

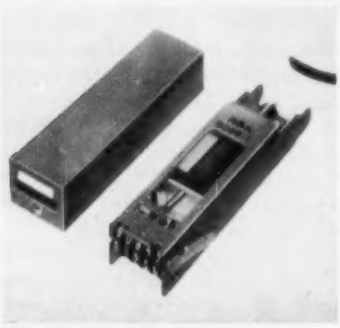
UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

NEW YORK, IVanhoe 3-2424 (Hempstead) BOSTON (Ashland) TRinity 2-4485
BALTIMORE, VAlley 5-3431 ST. LOUIS, JEfferson 5-7300
CHICAGO, LOngbeach 1-3042 · LONDON, OHIO, LOndon 1555 · LOS ANGELES, CLinton 6-2255

to 5 layers and may go higher depending on the application.

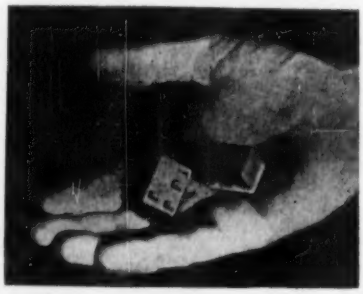


ELECTRICAL COUNTER
wheels cannot jam

NORTH ELECTRIC Co., Galion, Ohio, has announced a 5-digit electrical counter designed for reliable high-speed impulse recording. Type E-RSA-200 is compact and light in weight, and is suitable for installation in small spaces, measuring ¾ in. by 1⅞ in. by 4⅞ in. overall. Each counter is enclosed in a sturdy metal cover, available either as an individual unit or in strips of ten, with a common cover.

A flexible spring clip holds each unit firmly in place on the mounting plate. The mechanism of the counter is built so that the wheels cannot jam or get out of mesh. Each counter wheel is made of nylon for extra long wear. The coil of the unit is terminated with soldering lugs in rear.

Final inspection tests are made at a rate of 20 impulses per second.



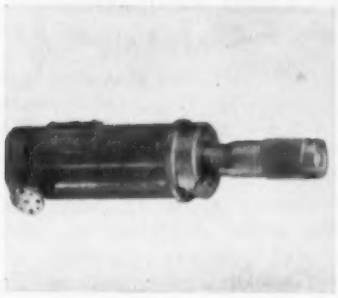
SINE SWITCH
has high shock resistance

METALS & CONTROLS CORP., Spencer Thermostat Division, Attleboro, Mass., has announced the Klixon K

series sine switches, for aircraft and industrial controls, actuators, relays and instruments. A highly precise sensitive snap switch is available for applications requiring small movement differential with high resistance to shock and vibration. The sine-curve switching element withstands from 0 to 500 cps at 10 g while continuously loaded the within 0.0002 in. of the actuation point.

Movement differential as well as operating and release forces can be adjusted and set to meet a wide variety of application requirements.

Once calibrated, the Klixon sine switch precisely maintains its operating characteristics throughout its life. Movement differential is 0.0005 in. minimum; shock, 200 g; temperature, −65 F to + 350 F; life, 100,000 cycles minimum; and size, 1¼ in. by ⅞ in. by 1 1/16 in.



CAVITY WAVEMETERS
cover 2.6 kmc to 90 kmc

DEMORNAY-BONARDI, 780 South Arroyo Parkway, Pasadena, Calif., is in production on a line of precision cavity wavemeters designed to give unusually broad coverage of microwave bandwidths. Only 11 sizes are needed to serve the entire range from 2.6 kmc to 90 kmc. Hence fewer sizes are required to cover wide segments of the total range. Each instrument measures all frequencies within the range.

Accuracy of these units is so high that they may be used as secondary standards, suitable for calibrating all other laboratory cavities. Units are nitrogen filled, and hence unaffected by changes in humidity or atmospheric pressure.

High resolution is accomplished with a precision micrometer-type turning screw which resolves

UNION

Now a complete line of "Selenium Slim" Rectifiers in the ratings you need

Now you can get UNION "Selenium Slims" in five ratings ranging from 1.25 to 20.0 milliamperes and maximum peak inverse voltages from 36 to 9360 with condenser input filter. They are available in diameters from ⅛" to ½".

These high-voltage, low-current rectifiers are made by a new process which assures *superior quality and trouble-free performance.* They are designed to outlast and outperform vacuum tube circuits at a comparable price.

"Selenium Slims" are made in assemblies of 1 to 260 miniature cells spring-loaded in either tough phenolic tubes or hermetically-sealed glass tubes. You can snap them into your circuits with standard fuse clips or solder in with pig-tail leads. Special assemblies are available to meet customer requirements.

A few applications are television receivers, electronic equipment, electro-static precipitators, business machines and Geiger counters.

Send for our new Bulletin 1007 for complete information, or contact one of our distributors listed below.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18 PENNSYLVANIA

NEW YORK, IVanhoe 3-2424 (Hempstead) BOSTON (Ashland) TRinity 2-4485
BALTIMORE, VAlley 5-3431 ST. LOUIS, JEfferson 5-7300
CHICAGO, LOngbeach 1-3042 · LONDON, OHIO, LOndon 1555 · LOS ANGELES, CLinton 6-2255

CVC thermocouple vacuum gauge offers high sensitivity, rapid response

This single-stage thermocouple vacuum gauge gives rapid readings in the 1 to 1,000 micron range. It is the *CVC* type TG-029, designed around a printed circuit.

The gauge is compact, portable, and priced considerably lower than the previous single-station model.

Its outstanding features include:

- No compensating adjustments—just plug it into a 115-volt outlet and turn on the power switch.
- Measures the total pressure of condensable vapors and permanent gases.
- Is not harmed by exposure to atmospheric pressure.
- One direct reading meter scale covers the range from 1 to 1,000 microns Hg.

New, more rugged gauge tube

This gauge uses the new TG-77 gauge tube which eliminates the fragile junction weld of previous tubes.

The tube is less subject to organic vapor contamination and its electrical characteristics do not vary appreciably from one tube to another.

The TG-029 is the latest addition to a complete line of *CVC* thermocouple gauges including the *battery-operated*, panel-mounted, single-station unit type TG-025; the *one-to-six* station unit type TG-09; and the *automatic control* unit type TG-010 which actuates a double-pole, double-throw relay at any predetermined pressure.

Specifications

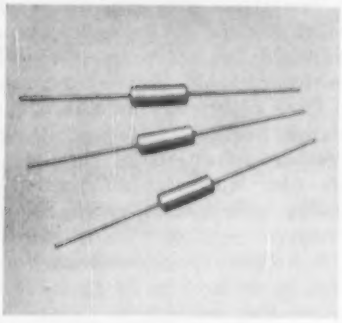
Range	1 to 1,000 microns
Case Dimensions	$5\frac{5}{16}$" x $6\frac{5}{16}$" x $6\frac{1}{16}$"
Weight	5 lb. 14 oz.
Power	115 V. 60 cycle, AC
Type TG-77 Tube	$2\frac{7}{16}$" with $\frac{1}{16}$" NPT nipple
Cord	10 ft.

For further information write for copies of *CVC* Data Sheets 9-35 and 9-37.

Consolidated Vacuum Corporation Rochester 3, N. Y.
a subsidiary of **CONSOLIDATED ENGINEERING CORPORATION**, *Pasadena, California*
CVC sales now handled through Consolidated Engineering Corporation with offices located in: Albuquerque • Atlanta • Boston • Buffalo • Chicago • Dallas Detroit • New York • Palo Alto • Pasadena • Philadelphia • Seattle • Washington, D. C.

plunger travel into 0.001-in. increments, and also with a multipage calibration chart furnished with the instrument.

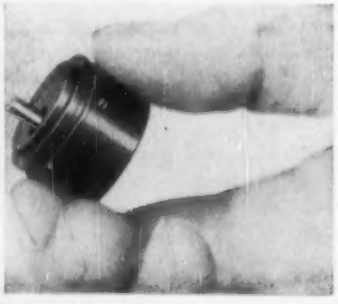
The units are designed for operation in a temperature range of −30 C to + 70 C. The line comprises reaction types, absorption and transmission types, all priced low. Literature is available.



MOLDED RESISTOR
with double insulation

ELECTRA MFG. CO., 4051 Broadway, Kansas City, Mo., has announced a new ½ w molded deposited carbon resistor. Its double insulation results in these advantages: complete mechanical protection, longer load life, better electrical insulation, greater moisture resistance and performance that exceeds all electrical requirements of MIL-R-10509A.

Complete information may be had by writing for bulletin No. 70.



GEAR HEAD
for subminiature motors

BOWMAR INSTRUMENT CORP., 2415 Pennsylvania St., Fort Wayne, Ind., has introduced a new subminiature motor gear head. The device measures 0.937 in. in diameter and adds

just ⅛ in. length to size 10 motors in its 26.4-to-1 reduction ratio.

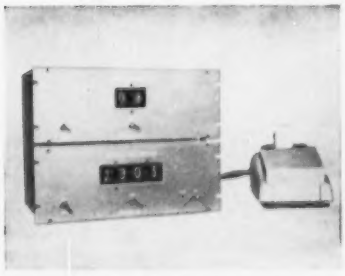
Model 937 speed reducer contains internally, in addition to its gear clusters, a unique adjustable slip clutch. Backlash is less than 30 minutes, and its weight is 1¼ oz.

Applications include computers, servo controls and general instrumentation where weight and size limitations are critical.

MAGNETIC TAPES
for electronic computers

ORRADIO INDUSTRIES, INC., 120 Marvyn Road, Opelika, Ala., has announced 50 different types of magnetic tapes for electronic computers. Reading and writing are performed at the rate of 15,000 alphabetical or numerical characters per second on Irish instrumentation tape No. 311.

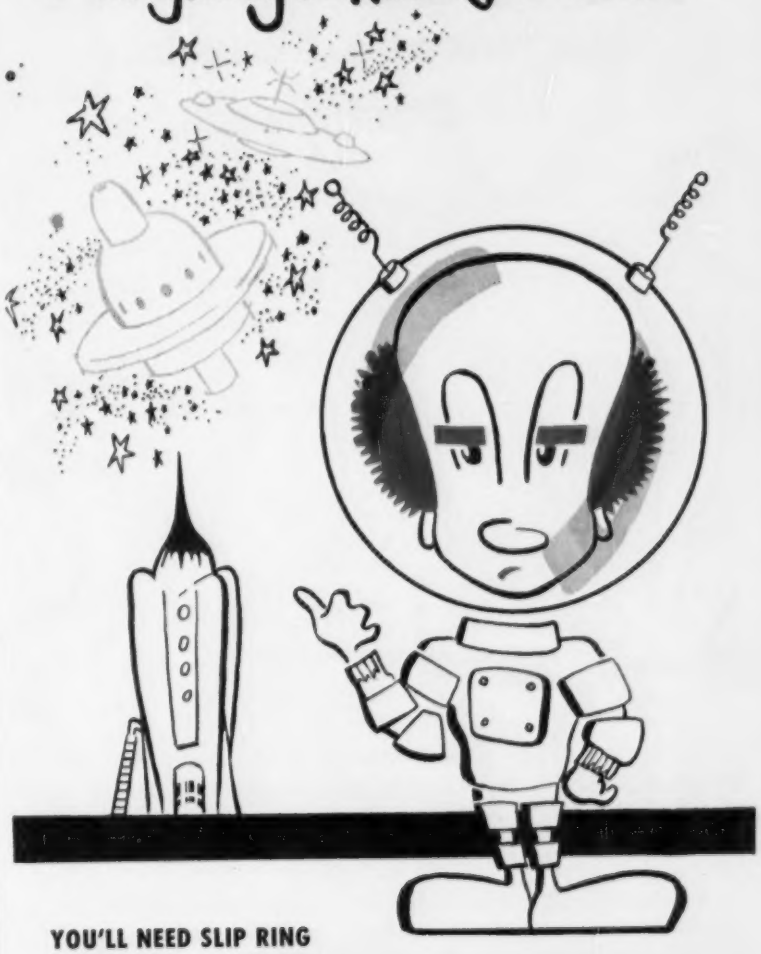
The 50 types of tape will include tapes on acetate and Mylar films in 1,200 ft, 2,400 ft, and 4,800-ft lengths, and in ¼, ½, ⅝, ¾ and 1-in. widths. The manufacturing technique produces a mirror-finish, and a tape virtually drop-out free, which is so important in electronic computer applications.



INPUT SCANNER
selects 100 data channels

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans St., San Diego 10, Calif. The IS100 input scanner sequentially selects 100 channels of data. When used in conjunction with the company's digital voltmeters and ohmmeters (and printer), one has a complete automation system for component and system testing. The IS100 consists of a series of stepping switches with all neces-

Designing A New Satellite?



YOU'LL NEED SLIP RING ASSEMBLIES . . . AND NO ONE CAN MAKE THEM BETTER THAN PMI

Before your new design leaves the drawing board, whether it be for a synchro or a satellite, if the plans call for a slip ring (collector ring) assembly, let us give you the benefit of our 13 years experience. From one circuit miniatures to 500-circuit giant installations, we can design, develop and produce the assembly to do the job.

PMI Engineers work out all production and design details. Give us a call for free estimate.

PMI

P M INDUSTRIES, INC.
270 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

Eccosorb CH
Microwave Absorber
for Darkrooms

Microwave Darkroom with
Emerson & Cuming Luneberg Lens under test

Eccosorb CH is a series of broadband absorbers reflecting less than 2% of the energy incident upon its surface. It is composed of enmeshed, rubberized fibers and made in sheets 2 feet by 2 feet in various thicknesses. Eccosorb CH is light weight and flexible. It is easily mounted and its natural, white surface color gives good light reflection.

Free Space Rooms are easily and economically built for indoor antenna measurements. Reflections are eliminated for all practical purposes. You can build your own microwave dark room or **we offer you a complete Free Space Room ready to use.** Emerson & Cuming engineers design and build special types for unusual conditions. Send us your specifications.

Another absorber, ECCOSORB HF comes in rods, sheets or molded shapes in several volume resistivities for waveguide terminations and similar uses. If you have a problem write for information on . . .

Plastics for Electronics

Emerson & Cuming, Inc.

869 WASHINGTON STREET, CANTON, MASS

PLASTIC FOAMS
LAMINATING AND IMPREGNATING RESINS
PLASTIC-FIBER GLASS LAMINATES
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ELECTRONIC EMBEDMENTS
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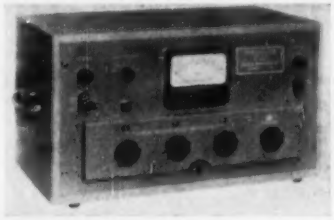
Columbia 5-2694

WEST COAST
McCarthy Associates
P. O. Box 36, Altadena, Calif
Sycamore 8-5790

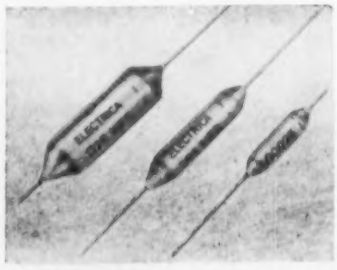
sary controls and power supplies.

It is rack mounted (7 in. by 17 in. by 16 in.) and operates on 115-v power. When used with digital voltmeter and printer, 100 channels can be printed out in approximately 5 minutes.



GENERATOR
for signal and sweep

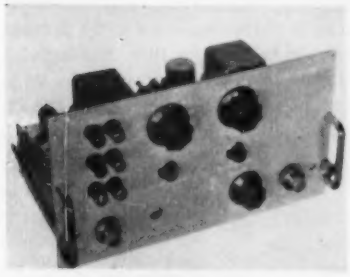
DECADE INSTRUMENT CO., 14 Maple Ave., Pine Brook, N. J. The Sweepalator serves as a combined signal generator and sweep generator. It features decade switching, crystal c-w or center frequencies and wide range calibrated output. Specifications include the following: range, 10 kc to 1.5 mc; steps, 1 kc in 3 decades; interpolation, calibrated 0-1 kc; accuracy, 100 cps; short term stability, ±25 cps; harmonic content, 3 percent maximum; output, 3 v rms; attenuator, 3 v, 1 v, 0.3 v, 0.1 v, 0.03 v, 0.01 v full scale; meter, calibrated 0-1 and 0-3 v.



CAPACITORS
with immersion-proof shell

ARNHOLD CERAMICS, INC., One East 57th St., New York 22, N. Y. The new Electrica capacitors function at temperatures from −20 C to +110 C and meets the demands of broadcast, tv and measurements fields for light weight and minimum size. Thermoplastic protective covering makes the capacitors air-tight, moisture and fungus

proof. Coating remains stable at all normal operating temperatures and insures high mechanical strength. The capacitors are economically priced. For complete data write for bulletin E.



PREAMPLIFIER
for oscillographic recording

SANBORN CO., 195 Massachusetts Ave., Cambridge, Mass., has developed a preamplifier which converts an average value of a-c watts into a proportional d-c voltage suitable for recording. Model 150-2300 a-c wattmeter preamplifier is designed as a front-end for plug-in installation in a model 150-200 driver amplifier unit, used in Sanborn one-to-eight-channel recording systems. Complete performance data and specifications are available from the company.

MAGNETIC COUNTER
is miniature type

VEEDER-ROOT INC., Hartford 2, Conn., has developed a small reset magnetic counter for moderate counting duty on the many applications where extreme long life is not required. Compact and easily

now in full production

Pacific* precision potentiometer-output

accelerometers

for fire control systems • power controls
computers • telemetering • stabilization

Pacific Scientific now offers you three new production model accelerometers – fully tooled, tested and approved. You can save both time and money with these full production units – especially if they're incorporated into your designs at an early stage. Listed below are some of the general specifications, and your nearest Pacific representative will be glad to discuss your specific requirements. Write or phone today!

	A15-1000 SERIES	A15-2000 SERIES	LA06-0100 SERIES
Range:	up to +15 G	up to +10 G	up to +15 G
Output:	Dual Potentiometers or switches —or one pot & one switch	Potentiometer	Potentiometer
Accuracy:	to 1%	to 1%	to 1%
Natural Frequency:	10 CPS at 0 to 4 G	Radically low for any given G range	Radically low for any given G range
Caging:	Electrical	Manual for Shipping only	Manual for Shipping only
Damping:	Viscous (Temperature controlled)	Air	Air

*TRADE MARK

Pacific

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IBM, long a leader in the growing field of digital computers for business, science, and government, offers a limited number of long-range creative assignments to outstanding men with Master's or Doctor's Degrees in Electrical Engineering, Physics, Mathematics, Chemistry or Physical Chemistry.

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At IBM men find the kind of facilities, associates and climate which stimulate achievement.

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Out of respect for the unusual man's talent and promise, IBM encourages qualified candidates to visit its Poughkeepsie, N. Y. laboratory—at their convenience, and IBM's expense. Write, outlining your qualifications, to: William M. Hoyt, International Business Machines, Room 412, 590 Madison Avenue, New York, N. Y.

IBM *Producer of electronic data processing machines, electric typewriters, and electronic time equipment.*

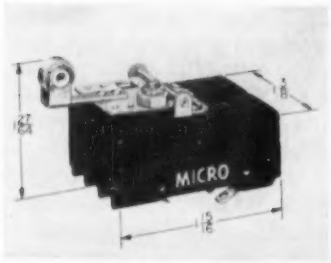
connected in series with any device having a contact arrangement, the series 1507 counter may be actuated by any type of switch, relay or photoelectric unit. Maximum recommended speed is 700 counts per min. Watt consumption is 4.5 at rated voltage (24 and 110 v a-c/d-c types are standard). Voltage variation is permissible up to 10 percent but not more than 10 v. The counter measures approximately 2¼ in. wide by 2½ in. high. Figures are 0.188 in. high.

BREAKDOWN TESTERS with range to 100 kv

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, N. J. Type PA-50 h-v a-c breakdown tester permits tests from 0 to a maximum of 100,000 v, continuously variable. It is rated at 5 kva available at breakdown. The PA-50 is entirely self-contained eliminating the dangers in multiple unit setups. The entire instrument is housed in a 30-in. relay rack, 6½ ft high. It is designed for either laboratory or production testing of such items as insulating tapes, transformers or any application requiring a variable, safe, dependable source of high a-c voltage.

DUAL SWITCH is single-actuated

MINNEAPOLIS-HONEYWELL REGULATOR CO., 4428 Wayne Ave., Philadelphia 44, Pa., has developed a new single-actuated dual switch designed for a wide range of in-



dustrial control and electronic applications. The 6AS13 is a low-force, double-pole switch consisting of two basic switching units operated by a single roller-lever actuator. It is available with a variety of lever lengths, either straight or formed levers, with or without roller. Basic switching units of the 6AS13 are listed by UL at 15 amperes—125, 250 or 460 v a-c, ½ ampere—125 v d-c and ¼ ampere—250 v d-c. Various other basic switching units can be used to provide higher electrical capacity for d-c circuitry, or for special circuit applications. Operating characteristics may be had for the asking.

AUDIO ATTENUATOR
manufacturers' type

CINEMA ENGINEERING CO., AEROVOX CORP., Burbank, Calif., is producing a new manufacturers' type audio attenuator for sound attenuation, sound mixing, special measuring and calibration units. The item, featuring self-wiping contacts of nickel silver, carbon composition and wire-wound resistors, is available in 150, 250 and 600 ohms. Resistance element values are standard 5-percent accuracy. Audio ladder controls have a 6-db inherent

PRECISION REGULATED
✓ STABILITY
(Long term .100 ppm—
Short term .50 ppm per hour)
✓ LOW RIPPLE
✓ LOW IMPEDANCE

Oregon Electronics
Model PR 300

Here's a voltage reference that can be depended upon for many laboratory functions, but specifically suited for calibrating meters, powering multi-stage amplifiers and computers.

OUTPUT TOLERANCE for 10% line voltage variation: ± .002% or less.
VOLTAGE RELIABILITY read on decade dials: .02% or 5 millivolts, whichever is greater.
OUTPUT VOLTAGES: (1) 10 to 310 volts in 1 volt steps @ 150 ma. max. (2) 0-150 volts continuously variable @ 5 ma. max. (3) 6.3 volts unregulated @ 3 amperes CT.

CLOSELY REGULATED
✓ Low Voltage—High Current
✓ DC POWER SUPPLY

Oregon Electronics
Model 32V15A

A Magnetic Amplifier Power Supply with output at 15 amperes continuously variable from 5 to 32 volts without switching.

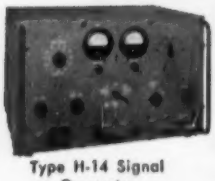
REGULATION: ±1% from no load to full load, ±1% from 105 to 125 volts input.
RIPPLE VOLTAGE: 1% RMS @ 32 volts and full load, increasing to 2% @ 5 volts and full load.

Complete specifications and details upon request—write or wire today.

Oregon Electronics
2232 EAST BURNSIDE STREET
PORTLAND 15, OREGON
BEImont 6-9292

MANUFACTURERS OF SPECIAL ELECTRONIC EQUIPMENT

you can rely on ARC Test Equipment!



Type H-14 Signal Generator

Type H-16 Standard Course Checker

Unerring precision is yours in the ARC Type H-14 Signal Generator! For either pre-flight or bench checks, this instrument tests *all* ARC Omni and Localizer Receivers with vital accuracy and speed. The H-14 clears one unit or a complete squadron . . . in under sixty seconds!

Checking up to 24 omni courses, to-from and flag-alarm operation, omni course sensitivity, calibration accuracy and left-center-right on localizer, the versatile H-14 also may be used to transmit voice instructions to pilots along with test signals.

ARC supplies the watchdog H-16 Standard Course Checker for *exact* course accuracy and phase measurement checks on the H-14, or any other omni signal generator. Both instruments available from factory only. Write for literature.

Dependable Airborne Electronic Equipment Since 1928

Aircraft Radio Corporation

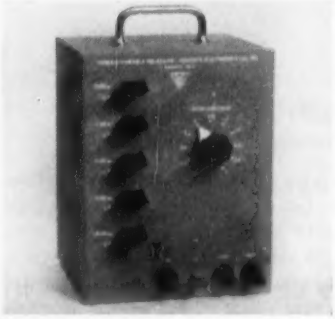
BOONTON, NEW JERSEY

Omni Receivers • 900-2100 Mc Signal Generators • UHF and VHF Receivers and Transmitters • 5-Watt Audio Amplifiers • 10-Channel Isolation Amplifiers • LF Receivers and Loop Direction Finders

insertion loss. All other network types of mixer controls have zero loss. The attenuator comes without knob and dial, but they are available as accessory items. Shipping weight is 8 to 12 oz per section.

GEAR HEAD
used with servo motors

STERLING PRECISION INSTRUMENT CORP., 34-17 Lawrence St., Flushing 54, N. Y. Designed for use with most Bureau of Ordnance servo motors, the model 600 series standard gear heads will fit units from 1⅛ in. diameter to 1¾ in. diameter. Special heads can be designed for servo motors outside this group. The company's standard gear heads have the output shaft concentric with the servo mounting diameters. Attaching these gear heads to a servo motor creates a clean, fully enclosed self-contained unit.



DELAY LINES
are continuously variable

ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J. Type 611 variable delay lines are continuously variable from 0 to

beyond 10 μsec. The continuously variable delay line in type 611a is essentially a condensed r-f cable with one conductor changed into a long thin coil and the other spaced closely to the first, thus producing a large amount of time delay, yet maintaining low attenuation at high frequencies. The tapped delay line in type 611b has 10 or more sections of m-derived LC networks with similar electrical performance to that of the step variable delay line.

DATA TRANSLATOR
includes visual readout

EPSCO INC., 588 Commonwealth Ave., Boston 15, Mass., announces the new Datrac data translator for ultraprecision voltage-to-digital and digital-to-voltage conversion. Model E Datrac converter provides 2 voltage-to-digital conversions per sec or 30 digital-to-voltage conversions per sec to an accuracy of ± 0.01 percent ± 1 least significant digit. The converter includes a visual readout and output conversion for direct control of printers, typewriters, or card punching equipment. Five decimal digits are provided. Three floating decimal ranges provide full-scale readings of ± 99.999, ± 9.9999, and ± 0.99999 v, thus providing 10-μv sensitivity. A number of optional features may be provided.

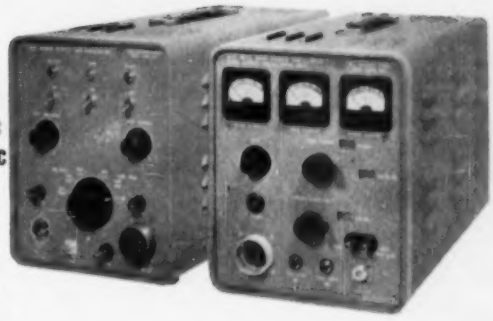
WAFERING MACHINE
is fully automatic

MICROMECH MFG. CORP., 1020 Commerce Ave., Union, N. J. The Micro-Matic precision wafering machine is made specifically for use

WIDE-BAND POWER OSCILLATOR

200 to 2500 mc/sec

40 watts at 200-400 mc
25 watts at 400-1000 mc
10 watts at 1000-2500 mc



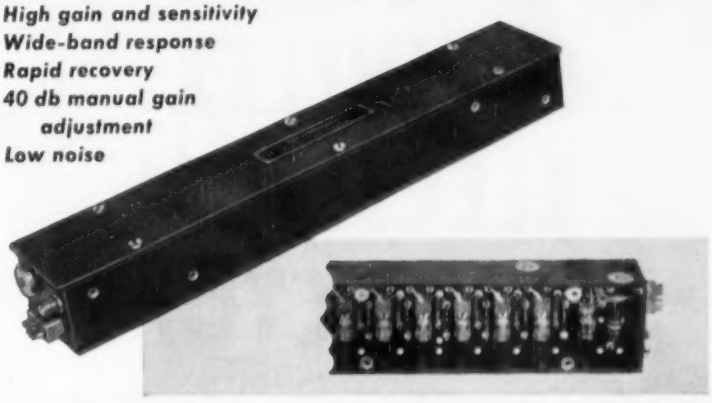
Provides exceptionally broad frequency coverage and substantial power output in a single source. Offers smooth tuning and precise resettability, with overlapping coverage of the full range in two bands.

Price, including oscillator and power supply-modulator, $2250.00 net F.O.B. Long Island City, N Y Write for free bulletin.

Frequency ranges....200 to 1050 mc, 950 to 2500 mc
Calibration accuracy.....± 1% or ± 5 megacycles whichever is greater
Resettability.....better than 0.1%
Modulation.....internal square-wave and sine-wave, 400 and 1000 cps; also external
Output impedance.....50 ohms (nominal)

Subminiature I-F AMPLIFIERS

- *High gain and sensitivity*
- *Wide-band response*
- *Rapid recovery*
- *40 db manual gain adjustment*
- *Low noise*



Designed for aircraft and electronic instrumentation, these amplifiers can be furnished to meet specific performance requirements. Typical specifications are given at right.

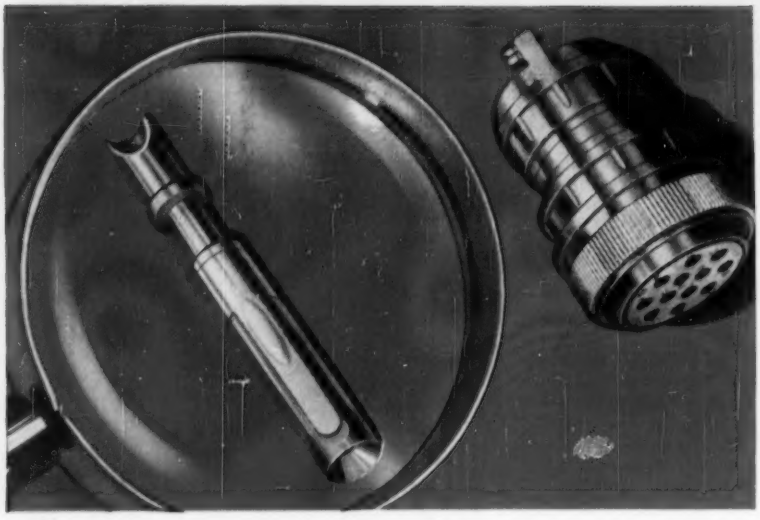
Model No.	Center frequency mc/sec	Band width mc/sec	Noise figure db	Gain db
M1154	30	12	1.7	100
M1155	60	12	3.7	100
M1156	90	12	5.0	100

Maxson Instruments products include: power oscillators, I-F amplifiers, mag-amp voltage regulators, frequency regulators for aircraft inverters, ultrasonic flowmeters, acceleration-sensitive switches, and statistical accelerometers. For detailed information, contact our main office, or Maxson District Office at:

Dayton, Ohio: 3229 Wonderview Drive Michigan 2232
Washington, D. C.: 202 World Center Building Sterling 3-7393
Beverly Hills, California: 8840 Olympic Boulevard Bradshaw 2-0316

MAXSON INSTRUMENTS
A DIVISION OF THE W. L. MAXSON CORPORATION

47-37 Austell Place
Long Island City 1
New York
Tel: RAvenswood 9-1850



"CLIP-TYPE" closed entry socket contact now standard in

Bendix

SCINFLEX ELECTRICAL CONNECTORS

CANNOT be overstressed—eliminates intermittent circuit problems resulting from socket contact malfunction.

Bendix-Scinflex* socket contacts have always been machined from bar stock. Stampings, with their required thin sections, can be easily overstressed.

Industry has also been plagued with overstressed spring leaves due principally to the misuse of test probes and lax tolerances on pin contacts. Bendix engineers now provide the only socket contact which completely eliminates all these problems.

The "Clip-Type" socket will not accept any oversize probe or pin, nor can one be forced into it. Also, no amount of wrenching or twisting of an acceptable pin or probe can possibly distort the spring clip. This new socket is now standard in all Scinflex connectors including those using solderless, high-temperature and thermocouple contacts.

Complete detailed information is available on request.

*TRADE-MARK

Bendix SCINTILLA DIVISION of Bendix AVIATION CORPORATION SIDNEY, NEW YORK

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

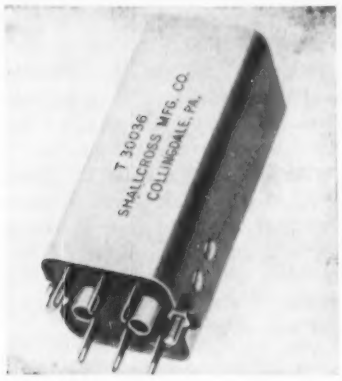
FACTORY BRANCH OFFICES: 117 E. Providencia Ave., Burbank, Calif. • 512 West Ave., Jenkintown, Pa. • Stephenson Building, 6560 Cass Ave., Detroit 2, Mich. • 5906 North Port Washington Road, Milwaukee 17, Wisc. • American Building, 4 S. Main St., Dayton 2, O. • 8401 Cedar Springs Road, Dallas 19, Tex. • Boeing Field, Seattle 8, Wash. • 1701 "K" St., N. W., Washington 6, D. C.

by the electronic industry for slicing and dicing germanium, silicon and quartz used in transistor and diode manufacture. It is equipped with control mechanisms and other automatic devices together with inbuilt accuracy. The wafers produced are consistent in thckness, and parallelism is controlled to within several ten thousandths variation. Any predetermined thickness may be obtained, ranging from 0.010 to 0.225. A 4, 5, or 6-in. diamond impregnated metal saw may be used for slicing and dicing. The working capacity of the machine is 6 in. transverse, 12 in. longitudinal and up to 12 in vertical.

AMPLIFIER
for 10 cps to 1 mc

SHASTA DIVISION, Beckman Instruments, Inc., P.O. Box 296, Station A, Richmond, Calif. Model 854A amplifier provides a choice of two fixed voltage gains of 10 and 100 times, over the frequency range of 10 cps to 1 mc. The instrument is

usable to higher frequencies with some slight sacrifice in uniformity of response, namely, ±1 db, 5 cps to 2 mc at a gain of 100 times. The circuit used introduces distortion of less than 1 percent when operating into recommended loads. Equivalent input noise is 20 μv on 100 times gain setting, and 80 μv with a gain of 10. Output voltage is a maximum of 10 v into a minimum load of 3,000 ohms. The input impedance is one megohm shunted by approximately 15 $\mu\mu$f.



DELAY LINE
for color television

SHALLCROSS MFG. CO., Collingdale, Pa., has announced an inexpensive, distributed-constant delay line designed for use as a compensating delay in the luminance channel of color tv receivers. The type T30036 delay line has an impedance of 4,300 ohms and uniform response to 4 mc. Phase characteristics also are linear within 5 percent to 4 mc. Total delay is 0.8 μsec. Rise time is only 0.1 μsec. The unit is enclosed in an aluminum can only 1⅜ in. square by 3¼ in. high, exclusive of terminals. Modifications of the basic electrical and physical characteristics can be made for quantity users.

FREQUENCY CHANGER
uses synchronous motor drive

GEORATOR CORP., Manassas, Va. Answering the need for a compact supply to furnish constant 420 cycles, with output frequency as invariable as the input, the unit pictured has been developed. Motor

PANELOC announces a new rotary latch

Saves Cost • Saves Time
Saves Space • Saves Weight

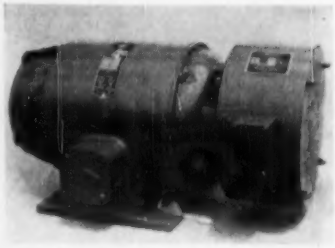
This new Paneloc Rotary Latch is a simple and economical, strong and durable fastener for access panels, electrical control panels, inspection doors, machinery doors, and other hinged or removable covers. It permits a larger access opening, operates quickly with a quarter-turn. Entire assembly on access panel itself, eliminating many installation steps; no special tools required. Only four simple parts; made of steel, cadmium plated. Three standard sizes now available, more to be added. Special sizes and finishes available on order. Cost very low, performance unsurpassed. Write for a catalog and price list for your file.

PANELOC...America's most versatile line of aircraft fasteners . . . Rotary Latches, Styles 1, 2, and 3 Panel Fasteners, High Performance Fasteners, Snap Fasteners.

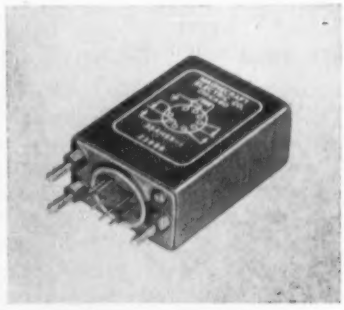
PANELOC—A product of Scovill

Scovill Manufacturing Company, Aircraft Fastener Div.
46 Mill Street, Waterbury 20, Connecticut
Please send me fastener catalogs checked:
( ) Rotary Latch ( ) Style 3 (MIL-F-5591A)
( ) Styles 1 & 2 (MIL-F-5591A) ( ) High Performance (NAS-547)
( ) Snap Fasteners (AN 227)
Send to:
Name Title
Company
Address

precision plumbing for microwave transmission
With unequalled experience in all of the accepted waveguide metals, Technicraft's thorough, stage-by-stage inspection and measurement policy assures delivery of only the most precise plumbing, both electrically and mechanically.
Technicraft employs the most advanced attaching techniques, including dip brazing. Manufacturing standards under constant supervision of experienced microwave engineers. Extensive lab facilities available for development and production tests.
For complete details and characteristics ask for our specification sheets.
TECHNICRAFT LABORATORIES
INCORPORATED
1550 THOMASTON RD. • THOMASTON, CONNECTICUT
Designers and Manufacturers of Rigid and Flexible Waveguide Assemblies, Microwave Test Plumbing and Components, Waveguide Systems.



is synchronous type, direct coupled in a compact unitary combination with a Nobrush 420-cycle generator. The resulting combination is free of brushes, exciter and slip rings, yet delivers as constant a 420-cycle frequency as the input 60 cycle. Without any regulator or delicate auxiliary, the unit will maintain output voltage to better than 2 percent for a given load. The generator creates no radio interference, is immune to damage from short circuits, will withstand moisture, dust and grit. Converters are available in this design (150 va to 5 kva), with any desired combination of single or three-phase input and output.



RECTIFIER RELAYS
for better a-c reliability

MAGNECRAFT ELECTRIC CO., 3350 W. Grand Ave., Chicago 51, Ill. Increased operating reliability throughout the wide range from 25 to 400 cycles a-c is provided in recently announced rectifier relays. Full wave rectifiers incorporated in these relays convert a-c to rectified d-c; thus providing d-c operation from a-c power supply. Advantages obtained in comparison with conventional a-c operation include: increased operating sensitivity, higher contact pressures, greater resistance to vibration, reliable operation through much wider variation in voltage or cur-

rent, freedom from a-c hum and, in many cases, reduced size. The rectifier relays are available with a wide range of contact combinations in hermetically sealed or dust-proof enclosures as well as open. Literature is available on request.

DIGITAL READOUTS
with advanced design

NON-LINEAR SYSTEMS, INC., Del Mar Airport, Del Mar, Calif. The NLS 3W series is the most recent and advanced design of the company's in-line, luminous digital readouts. Standard readouts are available with from one to six windows arranged horizontally. The edge-lighted Lucite plates are engraved with numbers from 0 through 9, decimal points and polarity signs. The numbers are ½ in. wide and 1 in. high, spaced 1⅛ in. on centers to provide maximum legibility. A new quick change terminal strip to which connecting wires can be soldered retains the lamps, maintains spring-loaded contact with each lamp, and eliminates resoldering connections when replacing lamps. Improved design of the interlocking frame members provides maximum precision and sturdiness. Volume production tooling and assembly methods provide high quality and variety at low cost.

NOISE GENERATOR
used with analog computers

AUTOMATION LABORATORIES INC., 517 W. 207th St., New York 34, N. Y. The low-frequency Gaussian noise generator provides a random voltage whose amplitude probability distribution is Gaussian to within 1

JET PROPULSION LABORATORY
OF THE
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

jpl

has positions now open in several fields of

MISSILE GUIDANCE SYSTEM DEVELOPMENT

This is an opportunity to associate yourself with the nation's foremost guided missile research and development facility.

1) *System Analysis*

Engineers, Physicists or Mathematicians are wanted for rocket guidance system planning and analysis. The work requires a combination of imagination and a high level of analytical ability. Experience in the engineering type problems of guidance or related equipment is very desirable. This overall system work provides the opportunity to become familiar with a broad variety of interesting and challenging fields. Excellent digital and analogue computers are available for use in the studies.

2) *Inertial Guidance*

Engineers and Physicists are wanted for missile inertial guidance component development. Work involves design, development and evaluation of gyros, accelerometers, integrators, stable platform systems and associated apparatus. Particular emphasis is placed on the problem of achieving component performance under severe environmental conditions, and on development of advanced testing techniques.

3) *Layout and Packaging*

Engineers are wanted for layout design and proof testing of electronic and electro-mechanical packages with emphasis on meeting vibration, temperature, and system operation requirements.

4) *Switching Circuits*

Engineers are wanted to design low power switching, control, and power circuits, with emphasis on reliability and ease of operation.

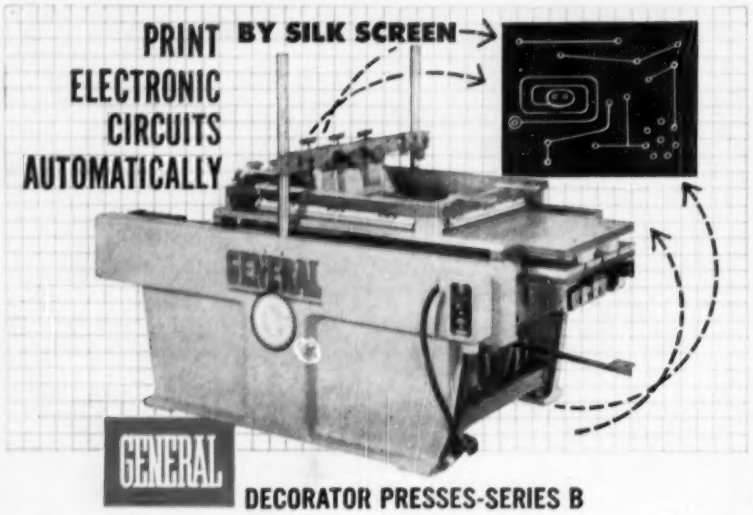
The Jet Propulsion Laboratory is located in a suburban area of Pasadena, California. It offers these advantages:

Desirable academic associations
Emphasis placed on research and development
Excellent laboratory and model shop facilities
Attractive salaries
A stable yet progressive organization

Interviews are conducted by members of our engineering staff.

Airmail your summary of qualifications to:

CALTECH | **JET PROPULSION LABORATORY**
4800 Oak Grove Drive Pasadena, California



DECORATOR PRESSES-SERIES B

■ The Silk Screen method is being widely accepted for preparing copper laminated plastic panels prior to etching printed circuits. General Decorator Presses put printed circuits on an automatic, high production basis. Bowed panels are held flat by vacuum. Line contact impression and accurate register give clean, sharp reproduction of fine lines. Controlled inking lays down a thick, uniform layer of resist.

Model No.	B1224	B1824	B1836
Sheet Size	13x25"	19x25"	19x37"
Speeds Up To	1000 per hr.	800 per hr.	800 per hr

ThermoJet DRYER Utilizes a new system for high speed drying of inks, resists and coatings by greatly accelerated evaporation of solvents.

GENERAL

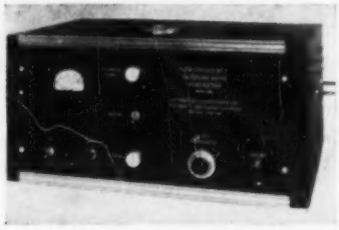
Write for complete information
RESEARCH AND SUPPLY COMPANY
572 S. Division Avenue
Grand Rapids 3, Michigan

GOLD INLAY KNOBS
IN ANY QUANTITY!
. . . and Never a Tool Charge

NEW *Gee-Lar* GOLD INLAY KNOBS

You can get beautiful gold inlay knobs, pointers, instrument controls . . . thousands of styles and varieties . . . in any quantity from GEE-LAR—The House of Knobs. They're available in both knurled and spring types, in either walnut or ivory backgrounds. For faster service and lower cost . . . plus the widest selection . . . get your Gold Inlay Knobs from GEE-LAR!

THE HOUSE OF KNOBS
GEE-LAR MANUFACTURING COMPANY
821 ELM ST. •



percent. The output frequency spectrum is flat to within 1 db from d-c to 27 cps in the standard model, but the frequency spectrum can be modified upon special request. Output voltage is 5 v rms, regulated to within 0.1 db, and available from a low source impedance. A continuously adjustable calibrated attenuator permits the output to be decreased from this value. A front panel meter continuously monitors the rms value of the output voltage. The instrument can be removed from the cabinet and mounted in a standard rack. It is intended for use with analog computers, simulators, servo testing and many other applications.

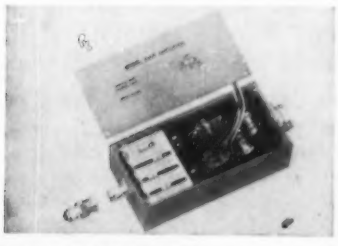
RELAY
operates at 10 milliseconds

HEDIN TELE-TECHNICAL CORP., 87 Dorsa Ave., Livingston, N. J. Relay 100-MS operates at 10 milliseconds and incorporates a thorough wiping effect. Available either hermetically sealed or with dust cover, it is designed for d-c applications in contact combination from spst to dpdt. Capacity is up to 1.5 amperes inductive and 5 amperes resistive with coil resistance to a maximum of 30,000 ohms. Bounce and chatter are eliminated by the built-in wiping action in the con-

tact movement. Drop-out if desired can be adjusted to about 65 percent of pickup. Wattage requirement is 250 mw per pole. The relay's applications include controls, recording, signal systems and electronic instrumentation, particularly in plate circuits and in circuits employing transistors.

TEN-MC SCALERS
for high-speed counting

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long Island City 1, N. Y. Model 4104 and 4124 10-mc scalers have a binary or decade scale of 4.096 or 1,000 respectively, or larger if desired. A five digit electrical reset register with any count predeterminable, a predetermined timer, a regulated h-v supply (0 to 2,500 v) for photomultipliers and the availability of a general purpose 10-mc preamplifier and pulse height discriminator make these units ideal for high-speed scintillation counting in nuclear and medical applications.



PREAMPLIFIER
for use with pickups

ENDEVCO CORP., 180 E. California St., Pasadena, Calif., announces a

NEW

PHAOSTRON
NONE FINER

"777"
V. T. V. M.
(VACUUM TUBE VOLTMETER)

The MODEL "777" V.T.V.M. is a completely self-contained, ready-to-use test instrument. Its accessories and the HF co-ax cable, DC Probe, AC line cord and instruction book all fit in the genuine California Saddle Leather carrying case that is furnished with the instrument.

42 Unduplicated Ranges
Illuminated Dial (5000 hour self-contained lamps)
Die Cast Chrome Finished Bezel
Metal Case, unbreakable, ultra compact
Doubly Shielded, time proven 200 microamp movement
Permanent Accuracy . . . 3% DC, 5% AC
Large, Easy to Read Scales 4⅞" Long
Color Coded Scales: green—ohms; black—AC, DC; Red—P. to P.
2 Zero Center Scales for FM Discriminator Alignment
Separate Range and Function Switches
Only 2 Jacks for All Measurements
New, High Style, Easy-to-Use Chrome Bar Knobs
Dual Purpose Handle also serves as AC line cord reel

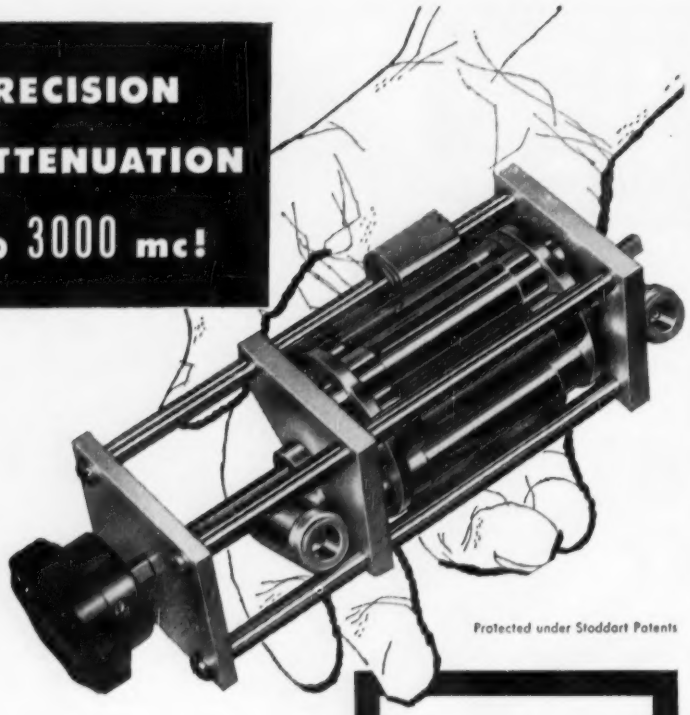
YOUR KEY TO EXCELLENCE

phaostron

"777" V.T.V.M. complete with Coaxial Cable, DC Probes and Leather Case at your PARTS DISTRIBUTOR $69.95

PHAOSTRON INSTRUMENT AND ELECTRONIC COMPANY
151 PASADENA AVE., SOUTH PASADENA, CALIF.

PRECISION ATTENUATION TO 3000 mc!



Protected under Stoddart Patents

six-position
TURRET ATTENUATOR
featuring **PULL-TURN-PUSH** *action*

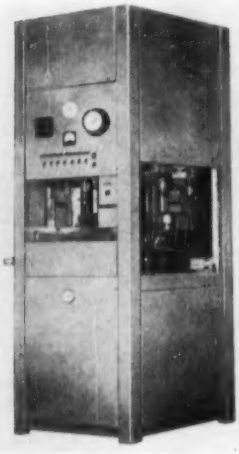
FREQUENCY RANGE: dc to 3000 mc.
CHARACTERISTIC IMPEDANCE: 50 ohms.
CONNECTORS: Type "N" Coaxial female fittings each end.
AVAILABLE ATTENUATION: Any value from 1 db to 60 db.
VSWR: 1.2 max., dc to 3000 mc/s, values from 10 to 60 db. As value decreases below 10 db, VSWR increases to not over 1.5.
ACCURACY: ± 0.5 db.
POWER RATING: One watt sine wave power dissipation.

SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATIONS

This new group of pads and terminations features the popular Type C and Type N connectors, and permits any conceivable combination of the two styles. For example, the two connector types, either male or female, can be mounted on the same attenuator pad, with or without flanges, so that it may serve as an adapter as well as an attenuator. Frequency range, impedance, attenuation, VSWR, accuracy and power rating are as designated above. Send for free bulletin entitled "Measurement of RF Attenuation."

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California · Hollywood 4-9294

new probe type of preamplifier for use with piezoelectric pickups permitting the user to trim the self-generating pickup output sensitivity to an even or standard value so that direct reading of physical parameters such as acceleration, force and pressure is possible with standard v-t voltmeters. Model 2614 features an input selector switch for the choice of 3 input conditions: 1,000 megohms for use with vibration pickups, extending the 1-f range of piezoelectric pickups to 2 cps; 1,000 megohms with d-c isolation for general uses; and 22 megohms for shock pickups, and fast recovery from overloads. In addition, a subminiature 3 decade shunt capacity switch is provided with a total capacitance from 10 $\mu\mu$f to 9,990 $\mu\mu$f in 10 $\mu\mu$f steps. The unit features amplifiers gains of 1, 3 and 10, with stability of 1 percent or better, a frequency response from 2 cps to 15,000 cps, and an output of 5 v into 2,500 ohms.



WET BLAST UNIT cleans tube leads

THE CRO-PLATE CO., INC., 747 Windsor St., Hartford 1, Conn. Designed for the high production rate cleaning of electronic receiving tube leads to insure good welding bond, a new rotary automatic is capable of blast cleaning, rinsing, drying and unloading at the rate of approximately 1,200 parts per hour. All chemical cleaning is eliminated through the use of the wet blast

method. Mounted vertically within the cabinet is a 6-station, air-operated rotary indexing table to which 6 vertically positioned work holding spindles are attached. Each spindle supports a chuck which, in turn, carries the tubes through each of the separate, baffled operating stations. The use of different work holding fixtures makes the unit highly adaptable to the finishing of a wide variety of other parts.

SILICON POWER RECTIFIER
for miniaturization purposes

AUTOMATIC MFG. CORP., subsidiary of General Instrument Corp., 65 Gouverneur St., Newark 4, N. J. The tiny silicon power rectifier illustrated, designed for use in equipment where miniaturization and high temperature reliability are vital, takes up only 3/100 cu in. of space and weighs only 7/100 oz. It should play an important role in electronic gear for guided missiles, supersonic aircraft and other military equipment. In the commercial and industrial field, the new rectifiers are designed for manufacturers of power supplies, magnetic amplifiers, communications equipment, and many types of computers, whose bulk can be greatly reduced by use of the tiny semiconductors instead of vacuum tubes or selenium rectifiers. They are available in 6 voltage ranges, capable of handling voltages as high as 1,000 v, with d-c output currents on the order of 300 to 400 ma. They operate at temperatures as high as 200 C.

Literature

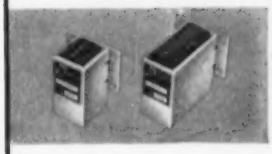
Electronic Test Instruments. Shasta Division, Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif., has available

taping the data of Aviation-Electronics

Davies magnetic tape equipment and systems for recording, reproducing, and analyzing data

STANDARD RECORDING & PLAYBACK HEADS

Precision multi-track heads, shielded for negligible cross talk. Precision gap alignment for uniform time and phase reproduction among the various tracks. Encapsulated in thermosetting resin. Complete range available from 2 tracks on ¼" tape, to 42 tracks on 2" tape—for use in data processing equipment, analog and digital work, telemetering, and automatic control.
WRITE FOR BULLETIN 55-B

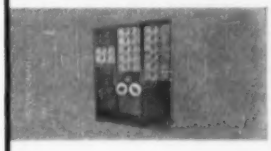


RECORDERS—PORTABLE & LABORATORY

Portable recorders, flight-proved to withstand extreme conditions, furnished as self-contained units or subdivided for space/weight distribution. Laboratory recorders are available with complete reproducing systems as an integral unit. Both have a full range of speeds for direct recording or recording by FM, PWM, or digital pulse—with full wow and flutter compensation.
WRITE FOR BULLETINS 54-D AND 54-E

REPRODUCERS

These unitized assemblies reproduce data from all Davies recorders with unparalleled accuracy. They include a tape transport mechanism, a speed control servo, and playback amplifiers with power supply, for direct recorded, PWM, or digital signals; and a high stability discriminator, in addition, for FM carrier systems. Units are available individually or as a complete system.
WRITE FOR BULLETIN 54-D



AUTOMATIC WAVE ANALYZER

This heterodyne type analyzer provides a complete fourier analysis (amplitude vs. frequency) of up to 14 inputs—all automatically. It is adaptable to any source supplying a repetitive signal in the range of 3 to 2000 cps to analyze signals from vibration, transients, noise, shock, power lines, etc.
WRITE FOR BULLETIN 54-C

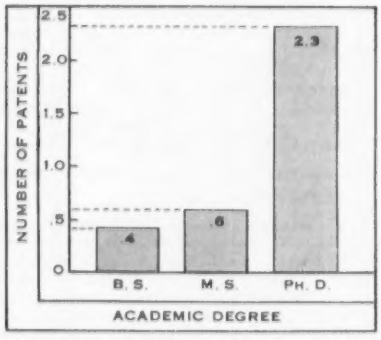
THE Davies LABORATORIES, INC.
4705 Queensbury Road • Riverdale, Maryland

SIDELIGHTS ON THE SCIENTISTS *number* **2** *of a series*

How many patents per Ph. D.?

Some of the young fellows on our staff have been analyzing our files of personal data regarding scientists and engineers here at Hughes. What group characteristics would be found?

With additional facts cheerfully contributed by their colleagues they have come up with a score of relationships—some amusing, some quite surprising. We shall chart the most interesting results for you in this series.



Data obtained from a 20% random sample of the 2,200 professional engineers and scientists of Hughes Research and Development Laboratories.

In our laboratories here at Hughes, more than half of the engineers and scientists have had one or more years of graduate work, one in four has his Master's, one in 15 his Doctor's. The Hughes research program is of wide variety and scope, affording exceptional freedom as well as exceptional facilities for these people. Indeed, it would be hard to find a more exciting and rewarding human climate for a career in science. Too, the professional level is being stepped up continually to insure our future success in commercial as well as military work.

Hughes is pre-eminent as a developer and manufacturer of airborne electronic systems. Our program includes military projects in ground and airborne electronics, guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in semiconductors, electron tubes, digital and analog computation, data handling, navigation, production automation.

RIGHT NOW *the Laboratories in Culver City, California, and the Missile Production facility in Tucson, Arizona, have positions open for engineers who are experienced in any or all phases of Test Equipment Design.*

SCIENTIFIC STAFF RELATIONS

Hughes

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

a new 8-page catalog describing its line of electronic test instrumentation including expanded scale voltmeters and frequency meters, vtvm's, oscillators, resistance bridges, power supplies, wide-band amplifiers, WWV receiver, decade inductor and various accessories.

Fluorocarbon Plastics. United States Gasket Co., P. O. Box 93, Camden, N. J. Those interested in Fluorocarbon plastics in their products will find a 20-page brochure helpful. "Inside U.S.G." is a concise, word and picture story of the company—fabricators of Teflon, Kel-F, Bakelite Fluorothene, and similar engineered plastics—and how it functions as a supplier of these plastics for electronic purposes. It highlights the specialized engineering and production facilities available to customer manufacturers to assure sound application and the most economical production of their requirements.

Ask for bulleting No. IN-554.

Electronic Design and Manufacture. Electronic Products Corp., 322 State St., Santa Barbara, Calif., has released a bulletin describing facilities for the design and manufacture of electronic equipment for military and industrial applications. The bulletin describes the company's facilities for the fabrication of cables and electrical wiring harness assemblies including facilities for braiding and molding.

The bulletin also tells of the company's activities in the assembly of electronic devices, design and manufacture of specialized electronic test equipment, power supplies, subminiature electronic assemblies and etched-circuit wiring.

Vibration Measurement. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. A 64-page booklet covers the meaning of vibration terms, description of vibration-measuring instruments, procedures, typical examples, and interpretation of results. Unwanted vibration, like noise, plagues nearly every industry and plant at one time or another.

There are also many types of

desirable vibrations. The first step toward understanding what is happening in all these cases is the measurement of the vibration, and a useful guide for this work is the "Measurement of Vibration."

Calibrator. Allegany Instrument Co., 1000 Oldtown Road, Cumberland, Md. A single-sheet bulletin illustrates and describes the type C calibrator, a universal tool for the standardization of wire strain gages, transducers and thermocouples. Features, operation information and specifications are given. Price of the unit discussed is $650.

Electronically Regulated Power Supplies. Tarc Electronics Inc., 48 Urban Ave., Westbury, N. Y. A new data sheet describes a line of four power supplies, electronically regulated and designed to meet the extremely close tolerances encountered in color and monochrome television. Specifications for units with output currents ranging from 50 ma to 600 ma are given.

High-Frequency Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa., has announced catalog data bulletin F-3 containing comprehensive data on characteristics, applications, resistance values, tolerances, terminations, insulation and voltage rating for type HFR high-frequency resistors. Included are charts and graphs.

Electronic Frequency Meter. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 1 of the *Journal* illustrates and describes the model 500 B electronic frequency meter, a 3-cps to 100-kc unit with discriminator output and expandable scale. Complete technical specifications are listed. Also included are specifications for the electronic tachometer indicator.

Master TV Manual. Blonder-Tongue Laboratories, Inc., 526 North Ave., Westfield, N. J. A 12-page master tv installation manual discusses all types of multiple tv systems, industrial tv systems and the proper use of Masterline equipment. Illustrated sections cover antenna and line installation, signal

3 reasons why your best buy is the

Berkeley MODEL 5571 FREQUENCY METER...

1. Wider Frequency Coverage...
   0-42 mc without plug-ins, extendable to 515 mc with Model 5580 VHF-UHF converter.
2. Universal-Instrument Versatility...
   a frequency ratio meter, 0-1 mc period meter, 1 μ sec to 10,000,000 sec time interval meter, 0-2 mc EPUT* meter, or 1 mc counter.
3. Reasonably Priced...
   unmatched in range, precision and utility at anywhere near the price.

FEATURES

- Direct-coupled input amplifiers
- Direct connections to digital printer, digital-to-analog converter, or data converters for IBM card punches, electric typewriters or telemetering systems
- Provision for external frequency standard input
- Coupling to WWV receiver
- Relay rack mounting if desired

BRIEF SPECIFICATIONS

Frequency Meas. Range: 0 cycles to 42 mc
Time Interval Meas. Range: 1 μ sec. to 10^5 seconds
Period Meas. Range: 0 to 1 mc (Period x 10, 0 to 100 kc)
Input Requirements: 0.1 v. peak to peak
Time Bases: Frequency: 0.000002 to 20 seconds, decade steps. Time Interval and Period Meas: 1 mc to 1 cps, decade steps
Accuracy: ± 1 count of unknown (or time base) ± crystal stability
Crystal Stability: Temperature stabilized to 1 part in 10^7 (short term)
Display Time: 0.2 to 5 seconds
Power Requirements: 117 v. ± 10%, 50-60 cycles, 260 watts
Dimensions: 20¾" W x 19" H x 16" D. Weight, 100 lbs.
Price: $1,745.00 (f.o.b. factory)

No other frequency meter offers all the advantages of the Model 5571 — why settle for less? Write now for complete technical and applications data, please address Dept G-12

78 Berkeley division
BECKMAN INSTRUMENTS INC.
2200 Wright Avenue, Richmond 3, California
INDUSTRIAL CONTROL SYSTEMS
ANALOG COMPUTERS · COUNTERS · TEST & NUCLEAR INSTRUMENTS

Corrections of Product Listings for the 1955-1956 Electronics Buyers' Guide

BOLD FACING AND ADVERTISING PAGE NUMBER ARE OMITTED IN THE FOLLOWING:

AUTOMATIC ELECTRIC MFG. CO.,
62 State St.,
Mankato, Minn.
ADVERTISING PAGE 560

RELAYS
- Impulse
- Latching
- Power
- Sensitive
- Sub-Miniature
- Telephone
- Time Delay

TIMERS—Automatic Cycle
TIMERS—Automatic Interval
TIMERS—Automatic Reset
TIMERS—Cycle
TIMERS—Motor Operated
TIMERS—Multicontact
TIMERS—Sequence

SWITCHES—Time

* * * * *

DIMCO-GRAY CO.,
207 E. 6th St.,
Dayton, Ohio
ADVERTISING PAGE 678

FASTENERS & FASTENING DEVICES

INSULATION PARTS
- Plastic Insulation Parts—Molded

KNOBS

RELAYS
- Time Delay

SWITCHES—Time
TIMERS—Automatic Interval
TIMERS—Motor Operated

* * * * *

EMELOID CO., INC.,
1239 Central Ave.,
Hillside 5, N. J.
ADVERTISING PAGE 539

KNOBS

ABP **electronics BUYERS' GUIDE** ABC

A McGraw-Hill Publication 330 West 42nd St., New York 36

distribution, closed-circuit tv, system maintenance and trouble-shooting procedures.

Simplified charts and tables, with specific examples, show how to calculate signal levels at any point. All the company's amplifiers, converters, tapoffs and accessories are fully described. Also offered is free engineering assistance.

Infrared Radiation Pyrometers. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A new 4-page brochure describes 2 infrared radiation pyrometers. The IR-2 is an industrial instrument designed for temperature measurement of moving objects in process as well as the location of hot spots in inaccessible equipment.

The IR-1 discussed covers a nominal temperature range of ambient to 1,000 C. As a control instrument, the unit described is highly suitable for fine measurements. As a control instrument it is outstanding for processes requiring high sensitivity near ambient.

Bobbin Winder. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill., has available a data sheet on the new compact front-loading multiple-head adjustable-length bobbin winder. Model 314-AM3 is pictured and completely described.

Technical data include dimensions, weights, types of windings, coil o-d and length, maximum distance between winding centers, wire sizes, tension equipment, built-in adjustable cam, gears, slow-start and winding speed, new one-way clutch, set up time, motor equipment, brake, counter, instant reset and start, automatic one-shot lubrication and new instant automatic brake release.

Dielectric Capacitors. Corson Electric Mfg. Corp., 540 39th St., Union City N. J. A 2-page, 2-color catalog sheet describes and lists a new line of ultrahigh-stability polystyrene dielectric capacitors. The capacitors discussed are designed for use where low leakage and low dielectric absorption are important. The sheet shows standard units which come in bathtub

and rectangular can types in 200, 400 and 600-v ratings, from 0.05 to 25 μf. Also described are special units which may be ordered with a variety of housings and terminals, still lower temperature coefficients, higher insulation resistance, silicone impregnation, lower power factors, lower retrace, and other special specifications.

Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin P-2a covers types PW-7 and PW-10 resistors. Comprehensive data on applications, design and construction, characteristics, ranges, power ratings, tolerance, stamping and derating are given. Charts and graphs are included.

Electromanometer. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. Bulletin 1547 illustrates and describes the type 37-103 Electromanometer, a precision, pressure-measuring instrument. A functional diagram is included, along with pressure balance information, specifications, applications and readout methods. A price list for the type 37-103 Electromanometer system is also included.

Captured Spot Displacement Follower. The Optronic Co., 136 Caputo Lane, San Jose, Calif. A 12-page folder illustrates and describes the Optron, a device for measuring displacement, runout or vibration of oscillating or rotating parts from 1μin. to 5 in. with frequency response from 0 to 100,000 cps.

The captured spot displacement follower discussed may be used to measure amplitude and frequency of any displacement or vibration within the specified ranges. Principle of operation, component description, overall assembly and specifications are included.

Cable Harness Tester. Industrial Instruments Inc., 89 Commerce Road, Cedar Grove, N. J. A single-sheet bulletin illustrates and describes the type A-1 electric cable harness tester, a compact, rugged instrument. The tester discussed makes continuity measurements,

Three of the world's largest producers of electronic equipment have recently made CUBIC Calorimetric Wattmeters standard test equipment in their laboratories and plants. For very good reason. No other instrument designed for power measurement gives you direct power readings... with such precision, and yet so simple in its application.

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Whether checking field equipment, developing or making acceptance tests on new equipment or magnetrons in the lab, or in production, one of CUBIC'S Calorimetric Wattmeters will be an invaluable addition to your test equipment. Standard laboratories calibrate secondary power devise, especially bridge type bolometer instruments. Exact calibration is provided month to month.

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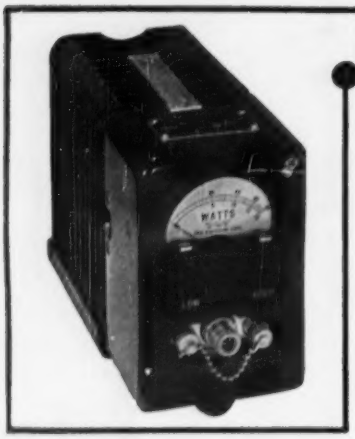

Models 611 and 612 are popular instruments in research and design laboratories, vacuum tube plants, transmitter manufacturing plants, and in fixed and mobile communication services.

They are ruggedly built for portable use, and are as simple to use as a D.C. voltmeter. The power absorbing load resistor is non-radiating, thus preventing transmission of unwanted signals which interfere with message traffic in communication services.

Frequency range: 30 to 500 MC (30 to 1,000 MC by special calibration)

Impedance: 51.5 OHMS—VSWR less than 1.1

Accuracy: Within 5% of full scale

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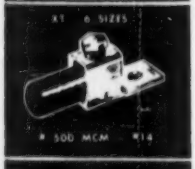

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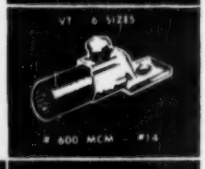

insulation resistance tests, dielectric strength tests, and provides terminations for the use of external instruments. It is designed for use in production or maintenance work. Price is included.

Precision Instruments. Allen B. DuMont Laboratories. Inc., 760 Bloomfield Ave., Clifton, N. J. A recent pocket-sized folder covers 13 new precision instruments. Included are 5 cro's including 21-in. indicator, portable field unit, and others to cover the range of d-c to 20 mc; 4 new oscillograph-record cameras; new high-quality vtvm and 2 low-distortion oscillators. Illustrations, brief details and prices are given.

Precision Cleaning. Cobehn, Inc., Caldwell, N. J. An 8-page folder deals with a solvent and equipment that safely spray cleans electronic components, contact points and precision instruments; and removes oil and grease, rosin flux, abrasives, lapping compounds and dust, dirt and lint.

The Cobehn solvent and equipment are described with an illustration of a typical installation of a bench unit. The booklet discusses the company's engineering service which is available without cost or obligation. Also available is a single page list of satisfied user companies of this technique of precision cleaning.

Boron-Carbon Precistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. An illustrated description of ½-watt molded Boron-Carbon precistors is contained in catalog data bulletin B-8a. It includes comprehensive data on characteristics, applications, wattage rating, tolerance, dimensions and insulation. Charts and graphs are also shown.

Lubricants. The Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn. Bulletin 103-A is a 4-page 2-color catalog of the variety of Molykote lubricants now available to industry. It lists 17 types of this molybdenum disulfide lubricant line and features a complete explanation, with diagrams, of the importance of this compound in extreme bearing pressure, and high,

low and normal temperature lubrication applications. Five new Molykote lubricants are discussed.

Also included is a selector chart which describes each Molykote type, the kind of carrier used in it, the temperature range in which it operates best, and the proper method of application.

Subminiature Relays. Elgin-Neomatic, Inc., 2435 N. Naomi St., Burbank, Calif., has issued a new brochure illustrating rugged subminiature relays designed for a wide variety of high-precision applications. The brochure includes the Neomite, a tiny precision relay, built in a standard transistor case for transistorized circuitry.

Also featured are the Neomatic VK and VR series, lightweight, compact units with excellent vibration resistance due to counterbalanced armature design. The brochure lists a variety of enclosures available in the VR and VK series and a complete rundown on specifications.

Wire-Wound Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Type MW wire-wound resistors are covered in the 4-page bulletin B-2a. Comprehensive data on construction, tolerance, power rating, marking, humidity, adaptability and frequency characteristics are given. Detailed charts and graphs are included.

Precision Indicators. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Data sheet No. 10.02a gives specifications, dimensions and operating characteristics of the Brown-Rubicon precision indicator. Now available in two overall ranges, the instruments described greatly speed laboratory-type electrical measurements.

Infrared Detectors. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn. The latest type of infrared detectors used as sensing elements in radiometers, pyrometers, infrared spectrometers and other infrared instruments are described in a new bulletin called "OptiTherm Infrared Detectors." It covers the characteristics, con-

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struction, circuitry and uses of these high-speed thermistor-type sensing elements.

Four-Watt Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin P-1a illustrates and describes the type PW-4 4-watt resistors. It contains comprehensive data on tests, applications, ranges, tolerance, stamping, rating and derating. Two graphs are included.

Power Supply. Technical Advisory Associates Corp., 30 Broad St., New York 4, N. Y. A single-page bulletin covers the AC700 power supply, a unit designed for use in critical resistance heating applications, for example the heat sealing of glass diodes.

The automatically recycling timer discussed allows precise timing of the heating cycle over a wide range. Output current is continuously variable up to 25 amperes. Full specifications are listed in the bulletin. Price of the power supply described is $350.

VTVM's. Technology Instrument Corp., 531 Main St., Acton, Mass., has prepared an 8-page brochure describing the outstanding features of its new extended range type 800A and 800B vtvm's. The 800A is priced at $275; the 800B, $325. Die-cut into the shape of the instruments, the brochure explains their operation and use in simple terms.

Also available is Laboratory Report No. 16, entitled "Basic Theory of the Type 800A Vacuum Tube Voltmeter," which discusses in detail the design consideration, giving basic circuits and development logic. Die-cut brochure No. I-105 and Laboratory Report No. 16 are available upon written request.

Delay Lines. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif., has available the second technical paper on Helidel delay lines, entitled "Criteria and Test Procedures for Electromagnetic Delay Lines." Technical paper No. 491 discusses general types of fixed and variable electromagnetic delay lines and defines conventional ter-

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WITHSTANDS VIBRATIONAL ACCELERATIONS

of 15 G's up to 2000 cps

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This newest Genisco Accelerometer is a rugged, oil-damped, potentiometer-type instrument designed to operate in the most severe missile and aircraft vibrational environment. For example, in a recent production test the GOH performed satisfactorily after vibrational environment of 15 G's up to 2000 cps. As further proof of its ruggedness, the GOH will withstand 40-G shocks of 5 millisecond duration on the sensitive axis, and steady-state accelerations of 30 G's on the non-sensitive axes and 10 G's on the sensitive axis without damage.

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Ranges: ±1 G to ±3 G's inclusive.
Natural Frequencies: 7 cps. to 12 cps.
Nominal Damping: 0.65 of critical at 75° F. Values between 0.4 to 1 set if desired.
Resistance: 14000 ohms (±5%); center tap at 0 G-point. Other resistances also supplied.
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Resolution: One part in 300 for standard potentiometer.
Noise Levels: Less than 10 mv at 0.1 ma brush current.
Linearity: Within 1% of full scale from best straight line through calibration points.

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minology. Common delay-line distortions are illustrated, methods for correction are analyzed, test procedures (both pulse and sinusoidal) and methods for measuring linearity and phase shift are described.

Deposited Carbon Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Comprehensive data on tests, applications, specifications, tolerance, ranges, performance and dimensions of deposited carbon resistors are available. Detailed charts and graphs are given in the 4-page catalog data bulletin B-4a.

Vitreous-Enameled Resistors. Ohmite Mfg. Co., 3680 Howard St., Skokie, Ill. A 2-page bulletin, No. 147, gives specifications and features of the company's new line of small wire-wound, vitreous-enameled resistors with axial leads. It shows the two sizes, rated at 5 and 10 w, that are carried in stock in a wide range of resistance values. Also shown is a price schedule.

Connector Bulletin. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page illustrated color bulletin describes features of the new 37-contact Continental connector suitable for airborne electronics. It includes electrical and mechanical ratings, mounting and clearance dimensions and diagrams. Write for bulletin CCC20.

Building Blocks. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A 12-page brochure describes a versatile array of electromechanical general purpose analog computer components. Called the Servomation building blocks, various component combinations provide the means for industrial control, design and mathematical problem solving, classroom demonstration and data processing. The units discussed are coordinated modular assemblies which match each other in all the important mechanical and electronic specifications. Featured are the Servoscope for analysis of phase and gain shifts, the Servoboard for breadboarding electromechanical

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Nuclear Reactor Brochure. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa., has available a brochure reviewing the amplifiers, power supplies, detectors and recorders applicable to nuclear reactor control. An illustration of typical reactor-control instrumentation is also shown along with panels in operation. Readers are invited to request the brochure on their own letterheads.

Magnetic Cores. General Ceramics Corp., Keasbey, N. J. A 4-page folder illustrates and describes Ferramic magnetic cores. Specifications and data on standard grades of Ferramic H are given. A table of magnetic properties of other Ferramic bodies is included.

Precision Oscilloscope. Laboratory For Electronics, Inc., 75 Pitts St., Boston 14, Mass. The model 411 Easy-Six, a wide-band, adaptable, precision oscilloscope, is described in a new 4-page brochure. The leaflet describes the way ease of operation has been brought to a complex, precision piece of test equipment. It also describes six plug-in packages which make it possible to use the oscilloscope as a delayed or undelayed model, a gated marker generator, a tv test instrument, a video switch and a long sweeps generator.

Plug-In Units. EECO Production Co., 506 E. First St., Santa Ana, Calif. The new 40-page illustrated catalog 827 presents circuit drawings and specifications on 36 of the company's different plug-in units for the design, development and production of electronic equipment. A number of typical applications are also presented to show the use of the units.

Magnetic Components. Milwaukee Transformer Co., 5231 North Hopkins St., Milwaukee 9, Wisc. A 16-page catalog lists various transformers and other magnetic components manufactured by the com-

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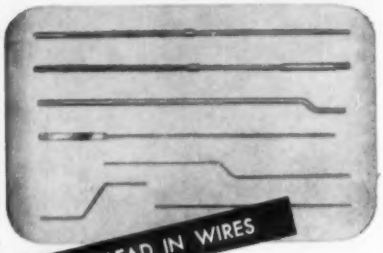

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pany. Case dimensions and ratings of many of the company's stock types are given and illustrated. The components described are engineered for commercial, industrial, laboratory and government applications.

Elapsed Time Indicators. Haydon Mfg. Co., Inc., Subsidiary of General Time Corp., Torrington, Conn., announces availability of product engineering bulletin No. 5 describing the new 60 and 400-cycle hermetically sealed total hour indicators now being manufactured for military applications. Complete specifications are listed. The rugged running time meters described indicate and repeat hours-of-operation up to 10,000 on a dial-type face.

Potentiometer Checker. Analogue Controls Inc., 37 W. 20th St., New York 10, N. Y. A 2-page flyer describes the model PC-15 potentiometer checker. The calibration standard instrument discussed finds wide application in receiving inspection of potentiometers and in calibration use where system performance may be improved by trimming potentiometers in accordance with individual error distribution as determined by comparison with an accurate standard. Complete operation information and technical specifications are included.

Electronic Instruments. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass. Catalog D is a 36-page booklet giving illustrated descriptions, chief features and specifications for a line of versatile electronic instruments. It covers 8 models of ascillators, 6 filters, 6 power supplies and an amplifier. Included are 4 pages of reference material and suggestions for ordering.

Electronic Thermostat. Minneapolis-Honeywell Regulator Co., 4428 Wayne Ave., Philadelphia 44, Pa. A 16-page illustrated booklet tells how electronic flexibility lets you sequence from your thermostats when you want to, locate your thermostats where you want to, and compensate your thermostats as

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"	F2125	Receive filter	170 "	255-4835 "	28
"	F9610	Oscillator network	170 "	255-4835 "	28
"	F6131	Send filter	120 "	300-4980 "	40
"	F8261	Receive filter	120 "	300-4980 "	40
"	F9631	Oscillator network	120 "	300-4980 "	40
F-S Carrier-Telegraph, 5+Dx	F11294	Send filter and oscillator network	120 "	3120, 3240, 3360 "	3
"	F11291	Receive filter and discriminator network	120 "	3120, 3240, 3360 "	3
"	F11209	Low-pass filter	—	0 to 2950 "	—
Carrier-Telephone (Type C System)	F15002	Channel filter	approx. 3 kc.	3-32 kc.	8
Carrier-Telephone (Type C System)	F15340	Oscillator network	approx. 3 kc.	3-32 kc.	8
Carrier-Telephone	F9511	Channel filter	4 kc.	4-36 kc.	8
"	F9520	Oscillator network	4 kc.	4-36 kc.	8
Carrier-Telephone (Type C System)	F2121	Line filter and balancing network	—	5-kc. crossover	—
Carrier-Telephone (Type C System)	F8910	Line filter and balancing network	—	3-kc. crossover	—
Carrier-Telephone (Type H System)	F1922	Line filter and balancing network	—	3-kc. crossover	—

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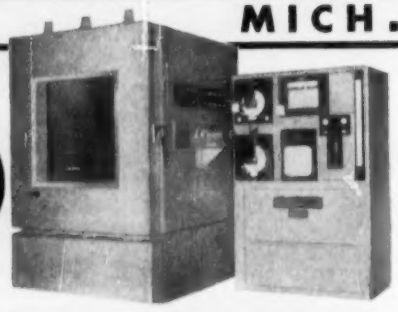

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Size:
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much as you want to. The booklet explains how electronic control of heating and air conditioning is as flexible as a strand of wire.

Selenium Rectifier Design. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J., has issued a 12-page booklet entitled "Federal Selenium Rectifier Design Data Guide." It gives engineers the factors that should be considered in the design of industrial and military rectifiers and tells why these factors are important. The explanations are given simply and briefly, and cover a wide range of rectifier applications.

Included in the data guide is a questionnaire which may be filled in and returned to the company for full evaluation of any specific design. The company's complete line of industrial rectifier products is also briefly described and illustrated.

Electronic Controls. Eaton Manufacturing Co., Kenosha, Wisc. Complete with illustrations and circuit diagrams, the 16-page bulletin EC-1 contains nontechnical, simplified information on the installation, performance and maintenance of the basic Dynamatic electronic control. The principles utilized to accomplish stepless speed control of Dynamatic eddy-current rotating equipment, using an a-c line as the power source, are described in detail. Precise speed control in addition to many other features which provide individual control requirements are presented.

Photoelectric Systems. Worner Electronic Devices, Box 118, Rankin, Ill. A new 20-page booklet on photoelectric systems covers the uses of electronic equipment in industry. It is written in nonengineering terms for easy understanding. Copies are available by request made on business stationery.

R-F Connectors. American Phenolic Corp., 1830 South 54th Ave., Chicago 50, Ill., has released a new 64-page D3 catalog covering the following r-f connector series: N, BN, C, LC, UHF, BNC, HN, between series adapters, coaxial cable fittings, push-on and Sub-

minax. Dimensions, mounting holes, weights, impedance, materials and matching cable types are given for each connector. The DC3 also contains illustrated connector cable assembly methods for each series. Requests for the catalog on company or government letterhead will be promptly filled.

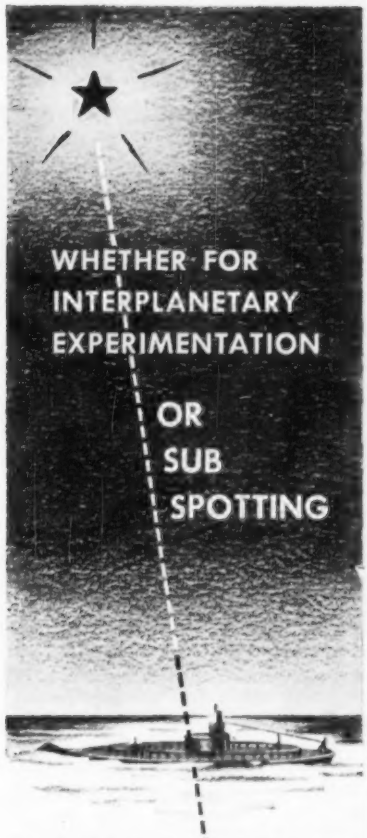
Horn Antennas. Waveline Inc., Caldwell, N. J. Microwave optimum standard gain horns are illustrated and described in a single-page loose-leaf perforated leaflet. The leaflet describes a set of 8 horn antennas covering the frequency range from 2.6 to 40.0 kmc. Gain of each horn discussed is 15.0 db ± 0.2 at the specified frequencies.

Sine and Pip Generator. Dalmotor Co., 1329 Clay St., Santa Clara, Calif. A new leaflet, form GPM-3, describes a small generator suited for continuous-indicating duty in radar instrumentation and similar applications. It produces simultaneously a two-phase sine-wave and two indicating pips per revolution.

Included in the leaflet are an illustration of the unit, a dimensioned outline drawing, a list of mechanical and electrical specifications and performance curves relating output voltage in volts to load resistance in ohms for both 20-cps (1,200 rpm) and 35-cps (2,100 rpm) operation.

Resistor Engineering Guide. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Comprehensive data on the company's complete line of resistors and special products are listed in the revised 1955-1956 official resistor engineering guide. Data given include JAN or MIL equivalent, rated wattage, standard tolerances, temperature rise, temperature coefficient, maximum operating temperature, ohmic values available, dimensions and approximate prices.

Precision Potentiometer. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. A recent technical paper, No. 573, tells what happens to the operating characteristics of a precision potentiometer during its working life. Entitled "Precision Potentiometer Life and



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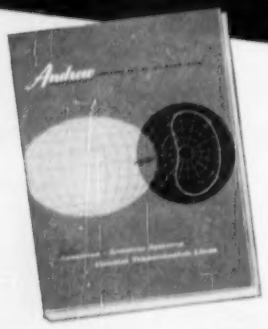

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Reliability," the paper discusses the effects of wear on operating characteristics (linearity, total resistance, noise, torque and shaft play) and the operating characteristics of potentiometers which are affected during use. Suggestions for increasing useful life are also given.

Punched-Tape Control System. Barnes Engineering Co., 30 Commerce Road, Stamford, Conn. A brochure describing the application of Binotrol, a punched-tape control system, to a turret lathe to make it completely automatic, has recently been published.

The 8-page booklet describes the operating principles of Binotrol and relates in detail how all of the motions of the lathe are completely controlled by the system.

Preparation of the punched tape, application of binary number coding to the lathe's functions, and advantages of the new lathe are also discussed. The Binotrol system described has an operating principle that is digital-to-analog, and contains few vacuum tubes.

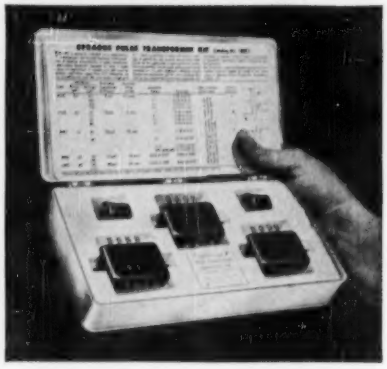
Four-Channel Carrier System. Lenkurt Electric Co., San Carlos, Calif. Volume 4, No. 10 of the *Demodulator* illustrates and describes the type 45CB carrier system, which operates in the 40 to 76-kc frequency range, and transmits up to 4 high-quality voice and signaling channels over an open-wire pair.

New design features incorporated in the system include transistors. Design features, block diagrams, frequency allocation and modulation plan, as well as possible applications, are given.

Photoelectric Pyrometer. Photoswitch Division, Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass. The 4-page illustrated bulletin PT556 contains descriptive data, specifications and dimensions on pyrometer type P2T, which provides new and greater flexibility in the fast and accurate measurement and automatic control of high temperatures.

The photoelectric pyrometer described operates over a range of from 1,000 to 5,000 F and will

pulse transformer kit simplifies circuit design



Sprague's new Type 100Z1 Pulse Transformer Kit contains five multiple winding transformers, each chosen for its wide range of practical application. Complete technical data on each of the transformers is included in the instruction card in each kit so that the circuit designer may readily select the required windings to give transformer characteristics best suited for his applications, whether it be push-pull driver, blocking oscillator, pulse gating, pulse amplifier, or impedance matching. Electrical characteristics of the transformers in the kit have been designed so they may be matched by standard Sprague subminiature hermetically-sealed pulse transformers shown in engineering bulletin 502B.

For complete information on this kit, as well as the extensive line of Sprague pulse transformers, write to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

CHARACTERISTICS OF KIT TRANSFORMERS

Type	Induct. Pri. (μH)	Induct. Leakage (μH)	Dist. Cap. of Pri. (μμF)	Max. Nom. P.W. Range (μsec)	Avail. Ratios
41Z2	0.5	2.5 4.0 4.5 7.0	5	0.5	1:1 2:1 3:1 5:1
41Z3	5.0	13 15 25 30	15	6	1:1 2:1 3:1 5:1
20Z7	10	20 40	12	12	1:1 8:1 1:1:1 8:8:1
20Z8	20	50 150	15	25	same as 20Z7
20Z9	50	150 210	20	50	same as 20Z7

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respond to temperature changes of 5 F, indicating this change on a meter and providing relay action to give a signal or to control heating devices. Accuracy of the unit is practically unaffected by oxides or scale formation on the work, or by smoke or vapors between the pyrometer scanner and the hot object. Plug-in chassis design of the pyrometer simplifies maintenance, and the use of rugged industrial-quality components assures on-the-job dependability.

Instrument Catalog. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y. Bulletin No. 364 is a 4-page folder dealing with solid front Acragages. Specifications are given on pressure, vacuum, compound, pneumatic and electric transmitters, receiver, test, chemical protectors and gages. Dimensional diagrams are included.

Potentiometers. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about the type K-2 potentiometer is available in a 4-page data sheet. The publication points out the widespread use of this potentiometer in industrial and research labs for potential difference measurements, for instrument checking, and for precise temperature measurements.

This concise sheet describes the circuitry and construction of the type K-2 in detail, and lists the accessories required for typical measurements. Ask for data sheet E-51(3).

Variable Inductance Coils. North Hills Electric Co., Inc., 203-18 35th Ave., Bayside 61, N. Y. A single-sheet bulletin deals with a new series of miniature variable inductance coils covering the 1 to 1,000-μh range completely.

Designed for such applications as video peaking, r-f and i-f amplifiers and filter networks, the coils described feature ceramic forms, split bushings and locknuts, and single D-hole type mounting.

Recording Oscillograph. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15,

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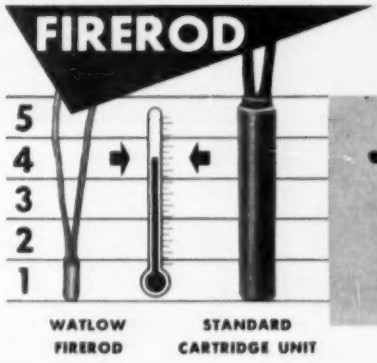

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Calif. Bulletin 1521B illustrates and describes the type 5-116 recording oscillograph. The unit discussed was developed to provide the dynamic test-measurement field with a high-precision, compact, reliable and extremely rugged multichannel recording oscillograph.

Features, specifications, prices and data on associated equipment and other Consolidated products are included.

Flexible Electrical Insulations. Irvington Varnish & Insulator, Division of Minnesota Mining & Mfg. Co., Irvington, N. J., has available a general catalog of flexible electrical insulation materials. It is a compilation of technical data sheets of the company's products which are grouped into three categories: coated products, varnishes and plastic products.

Included also are many useful charts and conversion tables. The catalog is supplied in a loose-leaf binder which makes it possible to change or add additional sheets as required.

Measurement and Control Systems. Daytronic Corp., 216 S. Main St., Dayton 2, Ohio. A 6 page folder covers linear variable differential transformer measurement and control systems for laboratory and industry. Illustrations, specifications and operating principles are included.

Plastic Dielectric Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A 6-page engineering bulletin (No. XC-201-4) illustrates and gives complete technical information on high temperature 165 C XC plastic film dielectric hermetically sealed tubular capacitors with exceptionally high insulation resistance, low power factor, and low dielectric absorption.

Included are capacitance listings, dimensions and voltages, dimensional drawings, and engineering data on test voltage, life test, power factor, insulation resistance, capacitance change, moisture resistance, vibration and typical curves.

Control Relay. Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio. A new line of sectional-

pole heavy-duty 10-ampere control relays, to occupy minimum panel space, is described in an 8-page bulletin. Bulletin PL 7305-PM completely describes the new relays, available in models with from 2 to 12 poles. (Up to 8 poles are available without double-decking).

The bulletin pictures each of the 10 models in the line; gives dimensions, enclosures, features and data on maintenance and pole conversion from normally-open to normally-closed; and lists the other literature and layout template kits which are available.

Magnetic Shields. Magnetics, Inc., Butler, Pa. Catalog MS-104, "Performance-Guaranteed Magnetic Shields," describes the shield alloys which are used, the dry hydrogen annealing process used for controlling shielding properties, fabrication and finishes.

Some discussion is devoted to mounting brackets and availability of single or multiple nested shields made from Mumetal alone or with alternate layers of Mumetal and copper. Thirty-three pages of working drawings are included showing the diversity of shields which the company manufactures, and describing materials used.

Battery-Operated pH Meter. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin No. 118 covers the battery-operated pH meter model 125. It illustrates and describes the unit which is powered by three ordinary radio batteries that last 2,000 hr. Price of the unit described is $145 including batteries and electrodes. The bulletin discusses a number of useful accessories which have recently been developed.

Portable Potentiometers. Allegany Instrument Co., 1000 Oldtown Road, Cumberland, Md. A 4-page folder contains descriptive information and illustrations of a line of portable potentiometers and millivolt sources used to calibrate amplifier gain and linearity, recording potentiometers, millivoltmeters and thermocouples. Prices of the units described are as follows: models P-55 and P-55M, $215; model P-55MB, $240; and model P-102, $345.

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Plants and People

Edited by WILLIAM G. ARNOLD

Manufacturers continue to expand plants and facilities for future growth. Technical societies elect new officers, honor engineers for technical accomplishments. Engineers are promoted and move to new positions in the industry

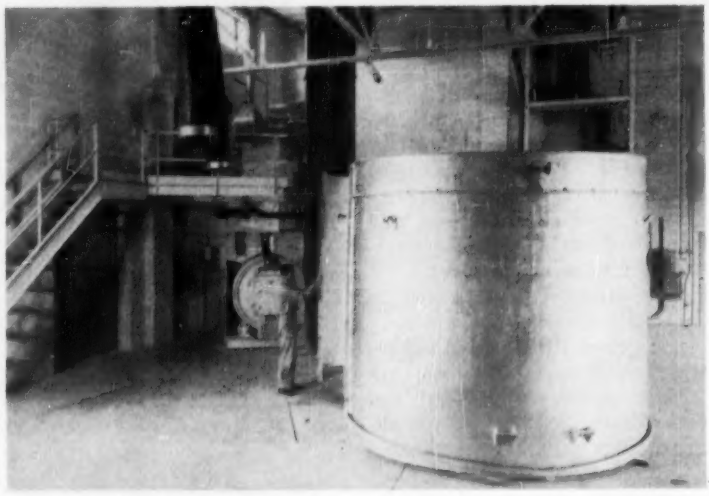
Mycalex Opens Synthetic Mica Plant In New Jersey

PLANT designed solely for the production of synthetic mica was formally opened in Caldwell Township, N. J. by Synthetic Mica Corp., wholly owned subsidiary of the Mycalex Corp. of America.

Production of the highly strategic material, under the trade-name Synthamica, has been under way for several months. At first the bulk of the synthetic mica produced will be pulverized and bonded with electrical glass to produce an electrical insulation material called Supramica. The material is currently being used in supersonic aircraft, guided missiles and nuclear development.

The formal opening of the new plant marked a 10-year effort to produce mica synthetically to reduce U. S. dependence on foreign sources for the material.

In the first batch of synthetic mica, produced at the new plant, the crystals, although not large, were larger than any produced in earlier pilot plant operations, and the chemical purity of the new batch was "above expectations." The company has also announced an expanded research and development program whose twin goal is to produce synthetic mica in forms that will eventually service all the critical markets where natural mica is used today, and to evolve modern mechanized methods to supersede the present laborious hand processing associated with natural mica.



Production furnace and auxiliary processing equipment in new mica plant

New Transistor Firm Expands Into Aviation Field

ACQUISITION of National Aircraft Corp., Metropolitan Airparts Co. and Florida Aviation's western division, was announced by Reagan C. Stunkel, who recently acquired the transistor facilities of Hydro-Aire. Stunkel was formerly vice-president of Hydro-Aire.

Metropolitan Airparts, Florida Aviation and the former Hydro-Aire facilities, now called Mar Vista Electronics, will operate as separate divisions of National Aircraft under the presidency of Stunkel.

Total employment of the combined operation is more than 300 employees, all of whom will be retained under the new organization.

R. C. Stunkel, president of National Aircraft, right, and H. H. Roads, president of Hydro-Aire

Headquarters of National Aircraft will be located in Burbank, Calif. adjacent to Lockheed Air Terminal. Some 30,000 sq ft of office and manufacturing facilities have been leased there from Pacific Airmotive Corp.

The Mar Vista Electronics division also will be located there. The manufacture of diodes, transistors, and other semi-conductor devices under the trade name, Marvelco, will be conducted under the direction of Robert Vaughn, vice-president of the firm.

Twenty-two acres of manufacturing buildings and hangars are occupied in Van Nuys, Calif. and will house the aircraft and manufactur-

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ing divisions of the firm.

Combined operation under the name of National Aircraft Corp. began in October. New officers in addition to Stunkel include: Jack Ferris, vice-president; L. D. Harrison, vice-president and treasurer; J. Guenette, secretary; Ruth Fitzgibbons, assistant secretary, and Charles Thompson, chief counsel.

Stromberg Begins $5 Million Expansion

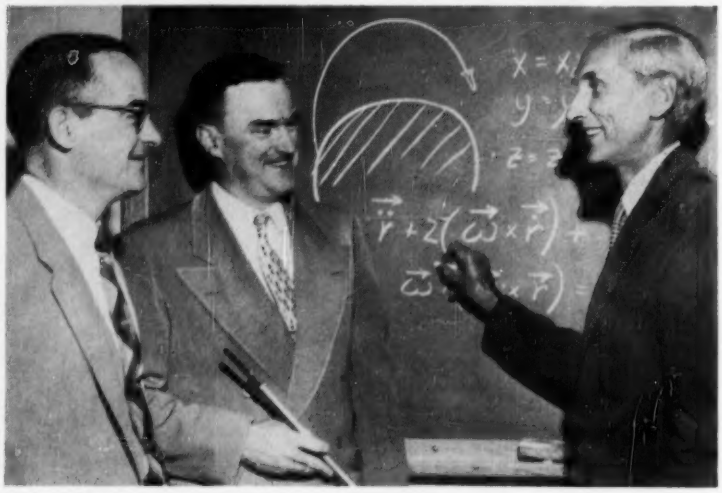
A FIVE-MILLION-DOLLAR expansion program has been started at the main plant and offices of Stromberg-Carlson, a division of General Dynamics.

More than a quarter of a million sq ft of floor space will be added to the firm's facilities.

The new building will adjoin the north side of the company's main plant in Rochester. It will be completed in 1957.

The building will be divided into three main sections: an administration and research building, providing more than 100,000 sq ft of space; a kitchen and cafeteria section; and a factory building providing approximately 110,000 sq ft.

Sylvania Dedicates Plant, Starts Another



NEW WALTHAM Laboratories of Sylvania, where guided missiles and the development of electronics means to detect and destroy them are a primary concern, were recently dedicated. Discussing the problems presented by an enemy missile and equations of its path are, left to right Dr. Oliver G. Haywood, manager of the Waltham laboratories; Paul Black, manager of the avionics laboratory and Dr. Edwin G. Schneider, manager of the missile systems laboratory.

Some 700 mathematicians, physicists, electronic engineers, and other members of the firm's avionics and missile systems laboratories work in the 120,000 sq ft building.

Sylvania also began construction of its new data processing center in Camillus, N. Y.

The 50,000 sq ft center, scheduled to begin operations February 1,

RETMA Board of Directors And Officers For 1955-56

1956, will house a Sperry-Rand Univac and will be the focal point of a 12,000-mile private electronic communication system linking the firms facilities in 51 cities.

By the leased Western Union network, these various installations will feed financial and production information to the center.

RCA Expands Research In Canada

James R. Whitehead

DR. JAMES RENNIE Whitehead of McGill University has been appointed to head the new RCA Victor Research Laboratories in Canada. Dr. Whitehead's work will be in the field of pure physics and electronics research not necessarily connected with company projects or developments.

Associated with him will be Dr. Sydney Wagner, also of McGill University, and a staff of Canadian physicists. The new laboratories will be opened before the end of the year.

From 1939 to 1951 when he joined McGill, Dr. Whitehead was associated with the British Government Telecommunications Research Establishment engaged on important war and defense projects. Beginning with work on the Mark I prototype aircraft system for radar identification, he put in 1,500 hours of actual flight testing of radar systems. He then designed the Mark III airborne equipment which was fitted to all Allied ships

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MIL-E-5400	Electronic Equipment, Airborne
MIL-E-8189	Electronic Equipment, Pilotless
MIL-I-6181	Electronic Equipment, Interference
MIL-STD-108	
MIL-STD-202	
MIL-L-770	Radioactive Material
MIL-L-25412	Luminescent Material—Fluorescent

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Comprising an extensive range of electroplated grid wires . . . Enamel insulated wires for precision resistors and potentiometers.

BASE METAL WIRES
Very small diameter — for filaments, thermocouples, resistance units.

PRECIOUS METAL WIRES
Produced in Platinum, Gold, alloys and pure metals — small diameter . . . Platinum alloy resistance wires . . . Pure Iridium and Rhodium-Iridium alloy Thermocouple Wire.

Write for Latest List of Products

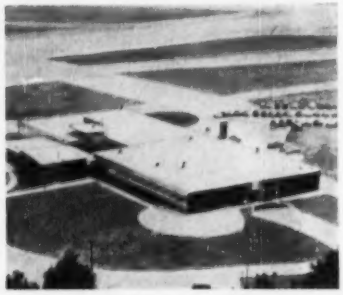
SINCE 1901

SIGMUND COHN CORP. 121 So. Columbus Avenue • Mount Vernon, N.Y.

and aircraft and was named head of the research group responsible for ground and airborne systems.

Dr. Wagner joined the physics department at McGill in 1946, and was appointed associate professor in 1954. From 1950 until this year, he also held a research appointment in the Eaton Electronics Research Laboratory, where he did research on electronic beams and traveling wave tubes.

Marion Instrument Moves To New Plant



MARION Electrical Instrument Co. transferred all its operations to a new, half-million-dollar plant erected at Grenier Field, Manchester, N. H. The facilities produce more than 85% of the components used in Marion panel instruments, meters, aircraft instruments and mechanisms.

The new plant has 40,000 sq ft of space.

Hoover Buys Control Of Electronics Firm

THE HOOVER Company has purchased controlling interest in Phebco, a Baltimore electronics firm.

The purchase will involve no changes in the personnel of Phebco, or changes in its current research and production programs. Phebco specializes in designing and making electronic equipment for industrial use, radar and guided missiles.

Hoover plans to expand and develop Phebco's current activities, and later to coordinate some of its work with that in the international Hoover organization.

Plans are to secure larger quarters for Phebco so it can expand its

research work on electronic equipment for industrial uses. Phebco is currently devoting most of its efforts toward developing and making guided missile electronic equipment.

Centralab Names Three Engineers

Robert L. Wolff

ROBERT L. WOLFF has been elected vice-president in charge of engineering of the Centralab division of Globe-Union.

Wolff, an employe of the company since 1937, has been director of products engineering since 1951.

Other appointments are W. S. Clark as division manager of the Badger Centralab plant and R. C. Anderson as division manager of Keefe plant. Anderson has been with the company since 1950 and Clark since 1948.

Columbia Acquires Armstrong's Station

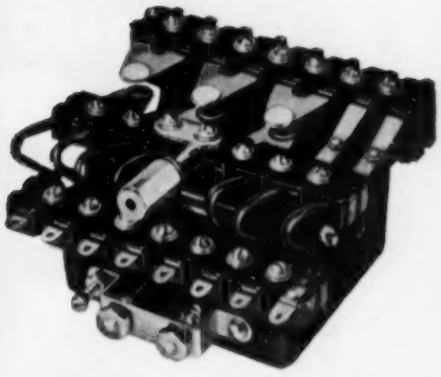
COLUMBIA University's school of engineering has acquired the steel radio tower and laboratory building in Alpine, N. J. from the estate of the late Major Edwin H. Armstrong, inventor of f-m radio and long a professor of electrical engineering at Columbia. The installation will be known as the Edwin H. Armstrong Field Laboratory and will be used by the department of electrical engineering for research in radiation and propagation of various types of radio waves, particularly with respect to their behavior in the atmosphere, ionosphere and upper atmosphere. It will also be available for military

HEAVY DUTY

Multiple Arm

RELAYS *by* SIGNAL

- Versatile — Rugged
- Cast Aluminum Base
- High Shock and Vibration Resistant
- Available AC — DC
- Contact Capacities Available 10; 35; 50 amp.
- Contact Combinations on Same Base
- Designed to Meet Many MIL Spec's



A superior relay that has endured the test of time . . . Specified for many years by America's largest manufacturer of electrical controls and communications equipment.

For complete data, write for Bulletin No. 30-6

Engineering representatives in principal cities

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THE BEST TEST FOR TV

TIC's TYPE 1105 VIDEO SWEEP GENERATOR

Price: $600. F.O.B. Carlstadt, N. J.

- High Output
- Flat Frequency Response
- Keyed Carrier Markers to Zero Amplitude
- 75-ohm Internal Impedance
- Sawtooth Sweep Signal

Expressly designed for testing Video equipment requiring a high level signal, the Tel-Instrument Type 1105 provides a 2.0 V. Max. p-p signal from a 75-ohm source into a 75-ohm load, with a sweep range from 50 KC to 10 MC. Features include: Ten selectable crystal controlled pulse-type markers supplied at either integral megacyle point, or as desired; flat output within ±0.2 db over entire range, attenuated over 60 db; and external markers.

TIC has a complete line of monochrome and color TV studio and production test equipment. Complete information sent at your request.

TIC Tel-Instrument ELECTRONICS CORP.

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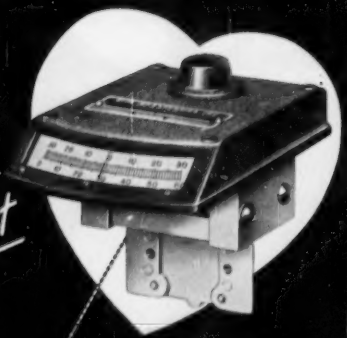
Make a GM PORTABLE D'ARSONVAL
GALVANOMETER
the Heart of Your Instrument



FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

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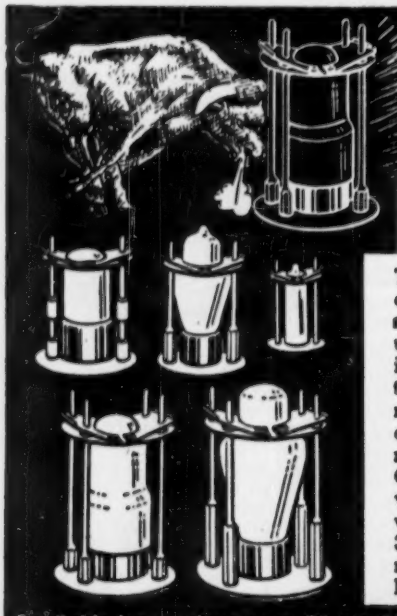


SHOCK PROOF
VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T12ZDL, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
1624 Stillwell Ave., Bronx 61, N. Y.

and industry projects.

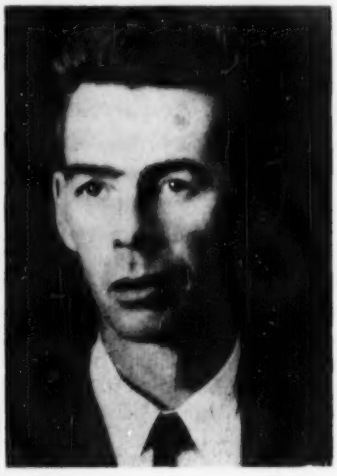
In addition to the Alpine site, Columbia also acquired from the Armstrong estate, 57 acres of land in the towns of Catskill and Hunter, New York. This area includes one of the taller peaks of the Catskill Mountains. These two sites plus Columbia's engineering camp near Litchfield, Connecticut, will form a triangular range for extensive field studies in radar and radio.

The tower and laboratory were built in 1938 by Major Armstrong to perfect frequency modulated radio transmission. During World War II the station was also used in radar developments.

Beckman Instruments Plans Expansion

BERKELEY Division of Beckman Instruments plans to build an addition to its plant in Richmond, Calif. The $350,000 expansion program will add 44,000 sq ft of working area to the plant. It is to be completed by mid-January. The addition will permit doubling of the work force and a 100 percent space increase for all departments.

General Ceramics Appoints Bouwmeester



JOHN H. BOUWMEESTER has been appointed vice-president of manufacturing and a director of General Ceramics Corp.

He was associated, until recently, with the Indiana Steel Products

PROVEN first truly effective product for prevention of Tarnish! NOX-TARNISH is a high grade packaging paper impregnated with a stable, non-volatile, non-toxic chemical composition capable of removing hydrogen sulfide from the atmosphere.

NOX-TARNISH eliminates production rejects because it insures bonding on soldering operations by keeping silver tarnish-free. It also keeps gold, cadmium or copper bright and free of sulfide stains.

In every case where tests have been made by industrial concerns with NOX-TARNISH, the product has proven far superior to any product on the market today. NOX-TARNISH is used by many of the largest manufacturers of electronic components, silverware and hollow ware.

Available in rolls, sheets or shredded. It can be fabricated into bags, envelopes, caseliners to meet individual packaging requirements. Write today for samples and technical bulletin N.T.

*Patent Applied for.

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Manufacturers of

RUST PREVENTIVES • V.C.I. PAPERS

ADHESIVES • AUTOMOBILE UNDERCOATINGS

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Company in a similar position.

Appointment of James W. Schallerer to the position of project engineer developing magnetic memory devices and allied equipment was also announced.

He was formerly with Lincoln Laboratory of M. I. T. as a staff member in charge of a magnetic material testing laboratory.

Texas Instruments Builds New Plant

CONSTRUCTION has begun on the new main plant for Houston Technical Laboratories, the geophysical instrumentation subsidiary of Texas Instruments. The 40,000 sq ft plant is being built on a five-acre tract in Houston, Texas.

When the modern new building is completed next spring, the lab's research, design, and manufacturing operations now being carried on in several rented buildings in Houston will be consolidated.

The new building will provide facilities for more than a hundred occupants.

Union Switch & Signal Realigns Engineers

G. W. Baughman, F. E. Lowance and E. F. Brinker, right to left, discuss a new inert train-carried coil for an electronic train identification system

UNION Switch & Signal, division of Westinghouse Air Brake Co., has made the following personnel and organization changes:

George W. Baughman, vice-president, formerly in charge of the railway signal engineering department, has been appointed to the staff of the vice-president and general manager.

A newly established position,

NOW!
more for your
connector dollar...
with these rugged nylon
tip and banana plugs!
Illustrated above—Johnson's new nylon insulated banana plug. Below—a cutaway view of the new nylon insulated tip plug ... two of the toughest, most durable connectors available today!

Look at these features:

- Shock-proof nylon insulating handles—won't chip or crack with the hardest usage.
- provides high voltage insulation.
- Highly resistant to extremes of heat, cold and moisture.
- Special design for simplified solderless connection of up to 16 gauge stranded wire.
- Economical—simple, functional engineering design gives you top quality at low cost.

SPECIFICATIONS

BANANA PLUG—nickel-plated brass construction with nickel-silver springs. Spring plug is .175" diameter, fits all standard banana jacks. **TIP PLUG**—recessed metal head is fully insulated, preventing exposure of metal surfaces when tip plug is engaged in any standard tip jack. Metal parts are brass, nickel-plated. Pin is .081" diameter—fits all standard tip jacks. Available in 11 bright colors to match Johnson nylon tip jacks.

Also New

NYLON TIP JACK AND INSULATING SLEEVE

Complete assembly includes a standard nylon tip jack with a threaded nylon insulating sleeve. Ideal for patch cords, this assembly is also excellent for panel mounting, where an insulated rear connection is desired.

Investigate today! Write for prices, further information.

E. F. JOHNSON COMPANY

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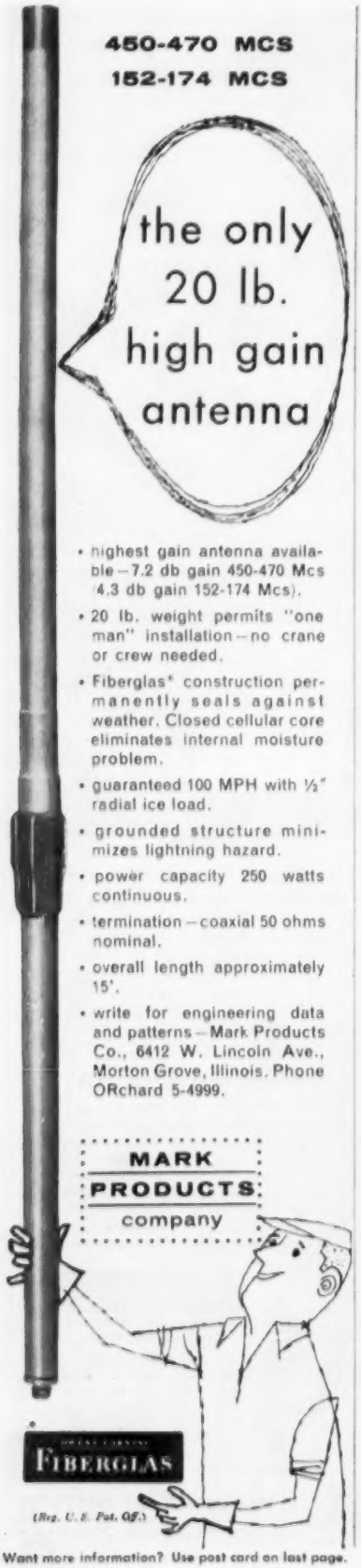

- highest gain antenna available—7.2 db gain 450-470 Mcs (4.3 db gain 152-174 Mcs).
- 20 lb. weight permits "one man" installation—no crane or crew needed.
- Fiberglas* construction permanently seals against weather. Closed cellular core eliminates internal moisture problem.
- guaranteed 100 MPH with ½" radial ice load.
- grounded structure minimizes lightning hazard.
- power capacity 250 watts continuous.
- termination—coaxial 50 ohms nominal.
- overall length approximately 15'.
- write for engineering data and patterns—Mark Products Co., 6412 W. Lincoln Ave., Morton Grove, Illinois. Phone ORchard 5-4999.

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director of research and engineering, will be filled by Dr. F. E. Lowance, formerly on the staff at Air Brake executive headquarters.

The present research department and the present development group in railway signal engineering will be merged to form a new research and development department, with E. F. Brinker as manager and D. P. Fitzsimmons as assistant manager.

In addition to his other duties Dr. Lowance will be acting manager of the railway signal engineering department with H. L. Ludwig assigned as assistant manager.

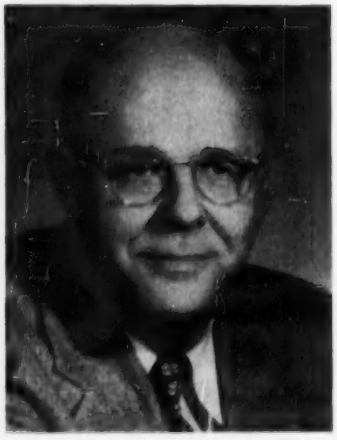
L. M. Engineering Constructs New Plant

THE L. M. ENGINEERING CO. of Los Angeles, Calif. plans to build a 36,000 sq ft building in Hawthorne, Calif. It will consolidate activities now housed in separate buildings.

The new $600,000 project, to be completed early in 1956, will include electronic, engineering and fabrication operations and office facilities. It is expected to increase production four-fold.

L. M. Engineering designs and manufactures special machinery, tooling, handling equipment, and electronic shakers. The electronics division makes testing equipment.

Rea Appoints Three Executives

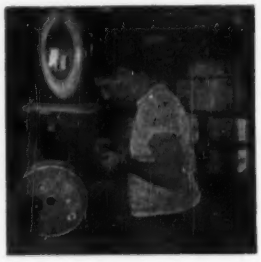


D. T. Gundersen

D. T. GUNDERSEN, who joined J. B. Rea as chief engineer in 1954, has been appointed vice-president in charge of engineering and produc-

ACME MAGNET WIRE *made by* SPECIALISTS *for* Over 50 Years

The Acme Wire Company's balanced pioneering experience of more than a half-century has made this company the leader in the field for the *best* in magnet wire. Highly trained personnel inspect Acme magnet wire at *all* stages of manufacture to make *sure* that this important product is of top quality.



An Acme Wire inspection station

The Acme Wire Company have been specialists for over fifty years in the field of *dependable* electrical insulations.

Do You Know These Other Acme Products?

Varnished Electrical Insulations
Coil Windings
Electrical Insulating Varnishes and Compounds

FOR OUR COMPLETE PRODUCT LINE... SEE electronics '55 BUYERS' GUIDE Pg. 701

ACME WIRE CO.
NEW HAVEN, CONN.

MAGNET WIRE • COILS
VARNISHED INSULATIONS
INSULATING VARNISHES AND COMPOUNDS

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tion. He was with Cook Research Laboratories as chief administrative engineer. Prior to that he was chief engineer for the Askania Regulator Co.

L. E. Schumacher, who has been sales manager of the Rea Company since 1953, has been appointed vice-president in charge of sales and customer relations. He was formerly sales manager for Logistics Research.

Francis A. Oliver has been appointed as manager of the newly created data storage devices unit of the company.

The new unit will be responsible for the development and manufacture of magnetic storage components.

Oliver, designer of the new magnetic components, was formerly head of research and development of magnetic storage devices at National Cash Register's electronic division. Prior to that he headed a similar division at the computer division of Bendix Aviation Corp.

Kester Enlarges Plant

KESTER SOLDER CO. of Chicago has expanded its plant facilities at Newark, N. J., by more than 50 percent. All phases of its Newark factory, manufacturing operations, warehouse and shipping areas, have been enlarged.

William Barkley Joins Rust Co.

WILLIAM J. BARKLEY has been appointed as vice-president of Rust Industrial Co.

He founded the Wireless Specialty Co. of Boston, Mass., in 1907,

designed for the user

by Shasta division — BECKMAN

MODEL 702A REGULATED POWER SUPPLY

features:

★ Regulation ¼% or better
★ Ripple less than 10 mv peak to peak
★ 0 to 400 v output @ 200 ma; continuously variable
★ 0 to — 150 v bias output @ 3 ma
★ Insulated + and — terminals permits use of high voltage with reference to ground
★ Exclusive SHASTA chassis construction

brief specifications:

Output voltages: 0 to + 400 at 200 ma
0 to — 150 @ 3 ma
6.3 ac @ 8 amp.
Ripple, peak to peak: 10 mv or less
Regulation: Better than ¼%, 0 to full load
Input: 105/130 v, 50-60 cycles
Dimensions: 8" x 12" x 10"
Price (f.o.b. factory): $205.00

Write today for Technical Bulletin 702A; please address Dept. SG-12.

Other Shasta Quality Instruments
Expanded Scale Frequency Meters and Voltmeters • Log Scale Voltmeters • Audio Oscillators Square Wave Generators • Power Supplies • Wide Band Amplifiers Bridges • WWV Receivers • Decade Inductors.

S-10

Shasta division BECKMAN INSTRUMENTS INC.

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AVAILABLE NOW!

The first complete catalog containing technical data on air-gas and oxygen-gas burner equipment is yours for the asking.

Wherever gas burners are used, AGF has been supplying them for 77 years. New Catalog C6A covers:

- Sharp Flame Ribbon Burners
- Fishtail Burners
- Needle Point Glass Fires
- Blowpipes
- Hand Torches
- Mixing Equipment
- Flow Meters
- Fire Checks
- Ball Joints
- Blast Burners
- Oxygen-Hydrogen Burners

Write for your copy today on your company letterhead.

AMERICAN GAS FURNACE CO.
130 SPRING STREET — ELIZABETH 4, N. J.

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Can you make your transformers smaller, lighter... with Class C encapsulation?

Where a higher hot spot is permissible, you can reduce the ounces and the inches of your transformers by ¼ to ½.

How? With *silicone rubber encapsulation*. This allows operation in the 160°C. to 200°C. range at a reduced size.

Silicone rubber encapsulation is one of the many services available to the communications industry at Caledonia. (We provide Class C transformers open and in cases, too.) All encapsulation is done *in our plant*.

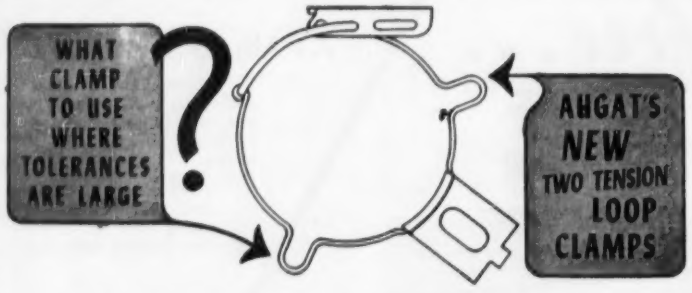
For help with this problem, and others involving transformers and related electronic assemblies, contact Caledonia.

When you have a transformer problem, call on

CALEDONIA

ELECTRONICS AND TRANSFORMER CORPORATION

Dept. E-12 Caledonia, N. Y.



Augat two-tension loop clamps are the long-sought answer for uses where tube base tolerances vary up to .040. The bands of these sturdy clamps are made of Beryllium copper, heat treated to retain original tension and nickel plated to withstand a 96 hour salt spray test with no adverse effect.

The remaining parts of Augat's two-tension loop clamps are made of 18% nickel silver.

Write today for catalog and samples.

AUGAT BROS. INC.

31 PERRY AVENUE • ATTLEBORO, MASS.

manufacturing crystals, receiving sets and spark transmitters.

Barkley later was associated with Dr. Lee DeForest as vice-president of the DeForest Radio Co.

His later associations included the position of general manager of the power and transmitting tube division of Sylvania. Following that, he joined the staff of Collins Radio Co. of Cedar Rapids, Iowa, where he acted in the capacity of general sales manager and executive vice-president from 1934 until April 1, 1955.

Barkley will head up an expansion program at Rust Industrial in the manufacture of remote control equipment and other electronic devices in the communication and navigation fields.

IBM Plans Swiss Research Lab

IBM PLANS to establish a research and development laboratory in Zurich, Switzerland. It is expected to be in operation the first of next year.

The new laboratory is intended to establish closer contact between the domestic IBM organization and development activities being conducted by European scientists and engineers in the accounting and data processing equipment field. The firm expects to be able to incorporate in its machines the technical advances of both European and American scientists.

Dr. Ambros P. Speiser, associate professor at the Swiss Federal

Ambros P. Speiser

Institute of Technology, has been appointed as director of the laboratory and will assume his new position after completing present work as head of the computer group at the Institute.

IBM also has leased a 20,000 sq ft building in San Jose, Calif., for development and pilot production of a new machine. Work at the new facility will start in December. The newly-acquired space boosts total working area of the IBM research and development laboratory in San Jose to 52,000 sq ft.

Bourns Adds Plant In Iowa

BOURNS Laboratories of Riverside, Calif., manufacturer of precision potentiometer instruments, has added a subsidiary plant in Ames, Iowa, devoted to the manufacture of miniature instruments.

Managed by Arthur J. Miller, the plant will have 25 employees and occupy an area of 12,000 sq ft.

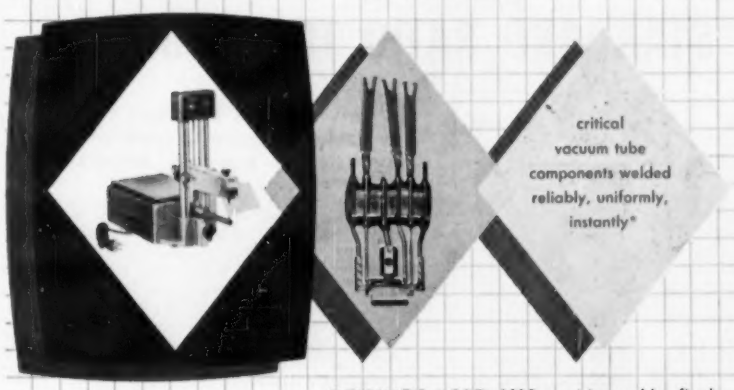
IRC Appoints Iowa Plant Head

Guy B. Entrekin

GUY B. ENTREKIN has been appointed plant manager of International Resistance's fifth and newest manufacturing branch plant located in Burlington, Iowa.

He was formerly IRC chief product engineer, and led a special research and development project on carbon composition resistors. Prior to joining the company seven years ago, he was product engineer

STORED-ENERGY WELDING SPEEDS VACUUM TUBE ASSEMBLY



WELDMATIC MODEL 1015 precision welder firmly joins wires, sheets and blocks of tungsten, nickel, nichrome, steel, silver and copper in tube element assembly for mass spectrograph guns. Molybdenum and tantalum also welded in plate assemblies.

*Made by Consolidated Engineering

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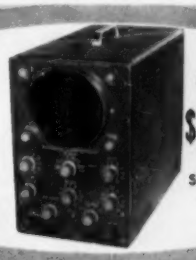
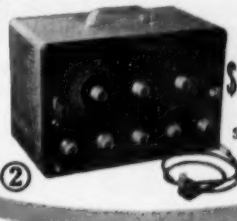
UNITEK CORPORATION
258 Halstead Avenue • Pasadena 8, California
Write for complete Technical Information on Stored-Energy Welding

for service and lab. work

Heathkit
PRINTED CIRCUIT
OSCILLOSCOPE KIT
FOR COLOR TV!



① Check the outstanding engineering design of this modern *printed circuit* Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles, 5 *times* the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail — retrace blanking amplifier — voltage regulated power supply — 3 step frequency compensated vertical input — low capacity nylon bushings on panel terminals — plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!



Heathkit TV
SWEEP GENERATOR KIT
ELECTRONIC SWEEP SYSTEM

② A new Heathkit sweep generator covering all frequencies encountered in TV service work (color or monochrome). FM frequencies too! 4 Mc — 220 Mc on fundamentals, harmonics up to 880 Mc. Smoothly controllable all-electronic sweep system. Nothing mechanical to vibrate or wear out. Crystal controlled 4.5 Mc fixed marker and separate variable marker 19-60 Mc on fundamentals and 57-180 Mc on calibrated harmonics. Plug-in crystal included. Blanking and phasing controls — automatic constant amplitude output circuit — efficient attenuation — maximum RF output well over .1 volt — vastly improved linearity. Easily your best buy in sweep generators.

Heath COMPANY
A SUBSIDIARY OF DAYSTROM, INC.
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...COMPLETE INFORMATION

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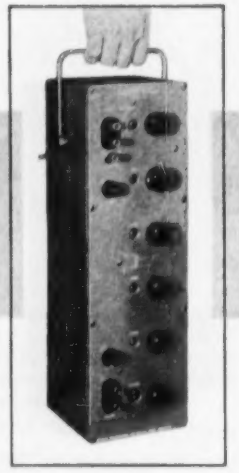
If your problem involves accurate division of AC voltage, you need a

STANDARD RATIO TRANSFORMER



AC voltages can be divided with accuracies as good as .005% and resolution as good as .00001%

The PT Series (7 models) precision AC voltage dividers have been specifically designed to divide AC voltage with unusual accuracy. Push button and rotary switch models available, in both carrying case and rack mounting styles. Models available to cover frequencies from 30 to 3,000 cps (to 10,000 cps at reduced accuracy). PT-5, illustrated, covers 50-3,000 cps, with continuous resolution.

For design and production use

Applications include: Bridge Ratio Arm, AC potentiometer; checking resolvers, servos, transformers, computers; for meter calibration, and as a ratio standard.

For complete information contact your Gertsch representative or

GERTSCH

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MARKEM® MACHINES

Solve "IN-PLANT" PRINTING PROBLEMS
- FASTER - NEATER - AT LOWER COST

The Markem Model 45AF Machine prints trade name, trade mark, specifications, etc., on resistors, condensers, capacitors, diodes, triodes, transistors, etc., at production rates. Feeds, prints, and ejects automatically. Quickly insertable type provides easy change in data being printed.

Write for further information. Submit sample of item you wish to mark.

WIRE LEAD COMPONENT PRINTING

MARKEM MACHINE CO.
KEENE 5, NEW HAMPSHIRE

for Western Electric.

The Burlington plant is expected to start production of deposited and boron carbon type resistors on or about December 1, 1955.

Bristol Engineering Expands Plant

BRISTOL Engineering Corp. has doubled its working area by leasing a 33,000 sq ft factory in Bristol, Penna. The newly acquired building will house the firm's electronic division and also its experimental and fabricating shops.

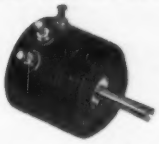
Harrington Joins Arthur D. Little

JOSEPH HARRINGTON, formerly of United Shoe Machinery, has joined the staff of the mechanical division of Arthur D. Little, consulting industrial research firm of Cambridge, Mass. Dr. Harrington will be concerned with the design, development and fabrication of automatic machinery for the assembly of intricate equipment, particularly in the electronics field. He will also assist in the technical audit services offered by the company. Dr. Harrington joined the research division of the United Shoe Machinery Corp. in 1932, where he became assistant director of research in 1947.

Precision Radiation Acquires Radio Craftsmen

PRECISION Radiation Instruments of Los Angeles, producers of radiation detection units, has acquired

Aerohm
Precision *wire-wound* Potentiometers



"Lo-TORK" POT LT ⅞

For minimum-torque uses in computer, servo, and selsyn service. Stainless-steel precision ball bearings. Maximum torque is 0.01 inch-ounce. Dissipates one watt at 80°C. Resistances—100 to 100,000 ohms. Weight is only ½ ounce. Ganging to six decks; internal clamps hold ¼" diameter. Standard linearity 0.5%; on special order 0.25%; toroidal winding allows winding angles to 360°; standard 354°.

AP 1⅛-S

AP ½-S

RT ⅞-S

MICRO-MINIATURE and MINIATURE

Series AP½-S—2 watts continuous at 80°C; resistances 10 to 20,000 ohms, 5% tolerance standard; diameter ½", depth ¼", weight ¼ ounce; sealed well enough for potting.

Series RT ⅞-S—3 watts continuous at 80°C; resistances 10 to 100,000 ohms; diameter ⅞", depth ½", weight ½ oz.; standard linearity 2%.

Series AP 1⅛-S—4 watts continuous at 80°C; resistances 10 to 150,000 ohms; diameter 1⅛", depth ½", wt. less than ¾ oz.; standard linearity 1%.

All precision-machined, with anodized aluminum bodies, line-reamed phosphor bronze bearings, centerless-ground stainless steel shafts, and gold-plated fork terminals. Fully sealed and fungus-proofed. Can be processed, on special order for use at 125°C. Aerohm potentiometers are individually checked for quality and performance.

MFG. INC.

Write for copy of our new catalog.

WATERS MANUFACTURING, Inc.
Waltham 54, Massachusetts
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

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Radio Craftsmen of Chicago, manufacturers of high fidelity components and equipment.

The new, wholly-owned subsidiary will be operated as a division of PRI, with the executives of Precision Radiation operating as the governing body of the new subsidiary.

Radio Craftsman, which has been selling directly to the consumer, will now market its products through dealers in a one-step distribution plan.

Sanborn Selects Engineering Head

Maurice S. Hartley

MAURICE S. HARTLEY has assumed the post of director of engineering for Sanborn Co. of Cambridge, Mass., manufacturers of medical and industrial instruments.

He was with Raytheon as product manager. He has also been connected with Imperial Oil of Canada, as senior research physicist, and previously was engaged as manager of the technical-commercial division of Philips Industries, also of Canada.

Raytheon Shuffles Equipment Operations

RAYTHEON has established two new integrated organizations in its equipment operations. One is responsible for commercial equipment and the other for government equipment. Each will have its own

WE'VE GOT 'EM

any amount
any kind
any time

plugs

CANNON ELECTRIC — **CANNON PLUGS**

USRC — **U.S. RELAYS**

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Aircraft Supply

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THornwall 2-8182

The right connection for the right connectors

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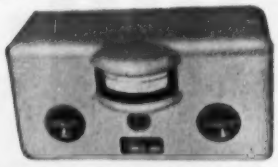
POWER
MEASUREMENT IN
LIQUID LOADS

MODEL 3901 THERMOPILE
$75.00 f.o.b. Grass Valley, Calif.

- 30 pair junction moulded in polyethylene
- All Plastic Case
- ¼" copper tube fittings
- Rapid take-down for cleaning
- From 10 watts to several kilowatts per unit

SPECIFICATIONS

Internal resistance	5 ohms
Voltage	1 millivolt per ° C
Maximum pressure	75 PSI
Dimensions	6-3/16 x 2⅛ x 2¾
Weight	15 oz.



MODEL 5800 CALORIMETER
$360.00 f.o.b. Grass Valley, Calif.

- A complete comparator to measured 60 cycle power, utilizing above thermopile.
- Built-in calibration circuit and heater.
- Sensitive, non-clogging flow valve.

SPECIFICATIONS

Weight	Approx. 21 pounds
Dimensions	8¼" x 9" x 17"
Maximum pressure	50 PSI
Range full scale	300, 600, 1500, 3000 watts
Meter sensitivity	1.5 mv
Thermopile sensitivity	1 mv/°C
Controls	Range switch, Calibrating valve, Calibrating potentiometers
Fittings	For ¼" x ⅜" plastic tubing

Other equipment for use in power measurements and specific equipment for microwave power measurement set-up.

- Model 5801 Calorimeter—Range 60, 150, 300, 600 watts.
- Model 3701 Water load calibrator heater.
- Model 4105 X Band Water load • 1000 watts CW 300 Kw. peak • Less than 1.2 VSWR over 7000/10000 mc.
- Model 5500/5501 Variable phase standing wave introducer at X band.

Let us send you full specifications on these tools for power measurement, or send for our complete catalogue.

- Glass Working Lathes, equipment.
- High Vacuum Pump and Gauge.
- Hydrogen Bell Jars.
- Vacuum Tube Laboratory Equipment.
- Spot Welder and Timers.

3237

Litton Engineering Laboratories
Grass Valley, California • P O Box 949

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engineering and development facilities.

Two new positions created by the change have been filled by John H. Beedle as manager of commercial equipment, and Gordon S. Humphrey as manager of government equipment. Each man has had more than a dozen years' service with the company.

Raytheon also announced that it has built a room with solid lead walls, for use in the x-ray study and inspection of electronic vacuum tubes.

The structure, weighing several tons, was designed by Raytheon engineers to house a powerful x-ray machine which is capable of maximum operation at 300,000 volts. Initial facilities make it possible to photo-inspect 20 tubes at a time.

Kuthe Labs Elects President

WILLIAM P. MAGINNIS has been elected president of Kuthe Laboratories of Newark, N. J., subsidiary of IT&T. He succeeds Dr. Herman Kuthe, founder and first president, who has been elevated to chairman of the board.

Prior to his present appointment, Maginnis was vice-president and works manager of the components division of Federal Telephone and Radio. For 21 years before his affiliation with Federal, which he joined in 1951, he was with RCA. His last position with that company was as head of component engineering at the Camden plant. Before that he was chief engineer at Bloomington, Indiana.

GE Expands Control And Radio Plants

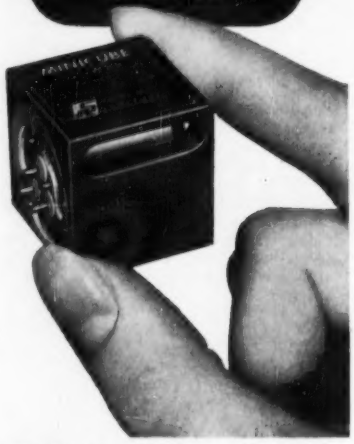
PILOT operations will start this fall at GE's new multi-million dollar plant near Roanoke, Va. The plant of more than 600,000 sq ft will house manufacturing and office facilities for the company's industry control department, currently headquartered in Schenectady, N. Y.

The new plant is expected to be completed about January, 1956, and the transfer should be completed early in 1957.

The plant will employ some 1,800

SANDERS
MINICUBE
BLOWER

ruggedly constructed for use on aircraft and guided missiles



The Sanders Minicube Blower contains both miniature blower and motor in a rugged, 1" cube. A single package, it is designed for use on aircraft and guided missiles operating under severe environmental conditions. It is operable over wide ranges of vibration, acceleration and temperature, and is suitable for many exacting applications.

The Sanders Minicube Blower can be used to:

- Eliminate hot spots in subminiature equipment
- Prevent fogging of lens or viewing glasses
- Cool Klystrons and other electronic tubes and devices
- Maintain uniform flow of air in restricted space

SPECIFICATIONS

Output: 3 cubic feet of air/minute
Input: 400 cps, 4 watts
Voltage: Model 1: 6 volts
Model 2: 26 volts
Speed: 22,000 RPM
Size: 1" x 1" x 1"
Weight: 1 oz.

For detailed specifications, write Dept. E

SANDERS ASSOCIATES
INCORPORATED
NASHUA NEW HAMPSHIRE

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persons upon completion of the move from Schenectady.

The company also has expanded its communication equipment manufacturing, warehouse, and office facilities in Utica, N. Y.

The company has signed a lease for 60,000 sq ft, or roughly half of the former Oneida Bleachery building in Utica.

The new space is to be used to augment two-way radio manufacturing operations and to consolidate various office and warehousing activities now at several locations throughout the Utica area.

The electronics division also announced that Lawrence R. Cohen has been appointed to the newly-created position of manager of application engineering in the laboratories department. He was previously sales manager for Army equipment. He joined GE in 1946 as a design engineer.

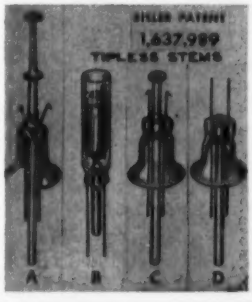
The new position will include liaison with outside customers, including the military services, to determine their technical trends and requirements and to advise them of General Electric's facilities for applied electronic research and advance electronic development.

Shannon Receives Ballantine Medal

DR. CLAUDE E. SHANNON, member of the technical staff of the Bell Telephone Laboratories, received the Stuart Ballantine Medal of The Franklin Institute for outstanding achievement in the field of communication.

Among Dr. Shannon's early contributions to the field of communication was the development of a mathematical theory of switching circuits which led to switching algebra.

His other contributions have dealt with the fundamental theory of transmission. Using statistical concepts in communication theory, he devised a quantitative means of measuring the size and complexity of the communication facilities needed to handle messages. He recognized that the fundamental factor limiting the ability to transmit information is noise. Using



You Name It EISLER Makes it...

Eisler tipless stem patents have been extensively used by incandescent lamp and radio tube manufacturers. Eisler patents are free and have been a source of protection to the radio tube and lamp industry. Why not consider your next machine an Eisler? Serving the Industry over 35 years.

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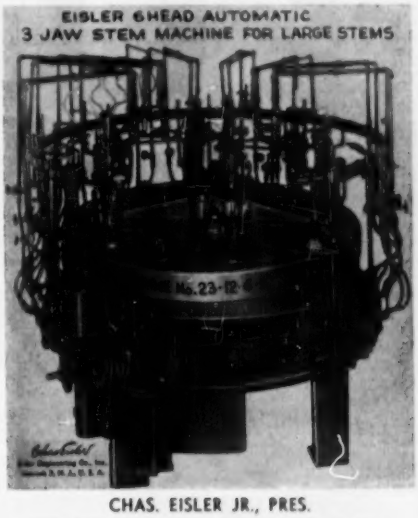

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EISLER ENGINEERING CO., INC.

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Simplicity of Design
Requires less than one-half the space usually needed for a lever switch.
SWITCHCRAFT INC.
"LEV-R-SWITCHES"
Plus Serviceability

Made in two and three position types; momentary and locking actions. Single hole mounting. Attractive hardware. Long springs without any "forms" at point of flexing insure long spring life. Springs insulated from each other by phenolic spacers with hard rubber tubing press fit through the stack—insures correct alignment of the contacts and provides high insulation resistance. "Soft" easy action actuator; real detent action on locking types.

Fine silver contacts, rated at 3 amperes, 120 volts, A.C. non-inductive load — standard. Also available on special order with larger silver contacts for higher currents and Palladium contacts for low current — low voltage circuits.

TELEVER SWITCH

For more rugged applications. Features unusual "T-Beam" frame construction —light design with ruggedness of a structural "T-Beam".

Full details in Catalog S-52—fourth printing—send for your copy.

SWITCHCRAFT INC. 1336 N. Halsted Street, Chicago 22, Ill.

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YOKE SPECIALISTS

- Military or special yokes and focus coils designed to your specifications.
- Production yokes for TV sets.

For your answer to yoke problems write Dr. Henry Marcy today.

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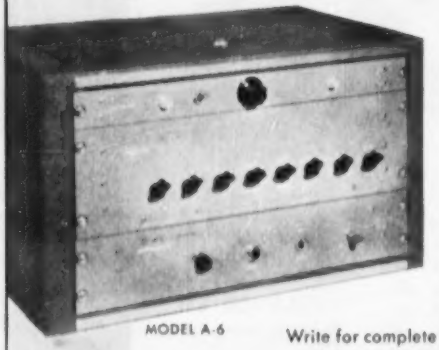
To supplement their line of ANALOG units
Rutherford adds a new
DIGITAL TIME DELAY GENERATOR ...Model A-6



MODEL A-6

Provides accurate and variable delays from 1 μs to 100 seconds in steps of 1 μs.

Available also are units with maximum delay ranges of 1,000 μs, 10,000 μs, 100,000 μs, 1 sec. or 10 secs.

Trigger type input circuit permits operation on slowly changing input signals.

Write for complete data on our DIGITAL Time Delay Generators: Bulletin E-A-6

For our ANALOG Time Delay Generator data, ask for:
Model A-2 (1 μs to 100,000 μs): Bulletin E-A-2
Model A-4 (.00001 to 10 secs): Bulletin E-A-4
Model A-5 (1 μs to 1,000 μs): Bulletin E-A-5

Rutherford ELECTRONICS CO.
Telephone: TExas 0-4362
3707 S. ROBERTSON BLVD.
CULVER CITY, CALIFORNIA

statistical notions, he devised a quantitative measure for the information handling capacity of communication means. The theory of these researches is contained in his paper "The Mathematical Theory of Communication." The contents of this paper have become known as information theory, and by virtue of their generality form a new and basic philosophy for the communications industry.

The AIEE presented him with the Alfred Noble Prize in 1940. During 1940-41, he was a National Research Fellow. He joined Bell Telephone Laboratories in 1941.

In 1949 the Morris Liebman Memorial prize of the IRE was awarded him for his "original and important contributions to the theory of the transmission of information in the presence of noise."

Sensitive Research Expands Facilities

SENSITIVE Research Instrument Corp. moved to new and larger production and engineering laboratories in New Rochelle, N. Y.

The building has complete facilities for manufacturing electrical indicating instruments. It gives Sensitive about three times the production and engineering facilities heretofore available.

Servo Promotes Three Executives

A. ERIC THEIS has been promoted to vice-president in charge of manufacturing at Servo Corpora-

A. Eric Theis

tion of America. Charles F. Healey was named vice-president in charge of administration; and H. Gordon Hawthorne, treasurer. Dudley L. Miller continues as secretary of the company.

Theis was production manager of Servo before his recent promotion. He is an engineer with over twenty years experience in the manufacture and production of radio communication, navigation, and electronic control systems and instruments.

Lenkurt Electric Enlarges Facilities

LENKURT Electric signed a two-year lease for use of a new building being constructed in San Carlos, Calif.

The building will have 14,400 sq ft of space.

When completed in December, some of the company's business divisions and some manufacturing operations will be transferred there.

The company now has 155,000 sq ft of floor space and owns or leases approximately 45 acres in the San Carlos industrial area.

Most of the equipment produced by Lenkurt goes to telephone companies in the United States and Canada for use in increasing long-distance circuits.

The company has more than 1,000 employees and a monthly business volume exceeding $1,000,000.

Clevite Units Select Executives

J. KNEELAND NUNAN has been named to the new position of vice-president and general manager of Clevite Research Center in Cleveland, Ohio.

Nunan has been president of Consolidated Vacuum Corp.

Transistor Products, an operating unit of Clevite, announced the appointment of E. F. Giguere as vice-president for sales.

He joined Transistor Products in 1953 and served as director of sales prior to his promotion to vice-president.

He was associated with Federal Telephone & Radio Co. for 14 years, rising to the position of broadcast sales manager. During 1952 and

lower costs . . .
improve design
save time . . .
with

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GEARS & PINIONS

Cast in one piece, at one time—and one low unit cost! Produced precisely to your specifications, permitting a wide flexibility of **design heretofore impractical.** One-piece assemblies can be cast with shafts or center holes, or in combination with cams, hubs, spacers, flanges and other mechanical elements. Maximum size: 1-5/16" outside diameter x 1/16" face width; wider faces for smaller diameters.

MANY COMBINATIONS AVAILABLE FOR LESS PRECISE APPLICATIONS FROM STOCK DIES AT NO TOOLING CHARGE.

COMBINATIONS die cast in ONE piece!

Write Today For Full Information and Samples

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has positions now open in the fields of

GUIDED MISSILE INSTRUMENTATION AND TELEMETERING

The Laboratory has the responsibility for the design and development of complete guided-missile systems such as the Corporal. Much of its success is credited to its small but outstanding telemetering and instrumentation group, which was one of the first in the nation to design and employ transistor telemetering systems.

This is an opportunity to associate yourself with the nation's foremost guided-missile research and development facility. Applicants must have at least a B.S. in a related field from an accredited university with good academic standing and meet one of the following experience requirements:

1) Experience or training in transistor circuit design.
2) Experience in the development of missile telemetering systems.
3) Experience in instrumentation system design and data processing.

Airmail your summary of qualifications and references to:

CALTECH | JET PROPULSION LABORATORY
4800 Oak Grove Drive Pasadena, California

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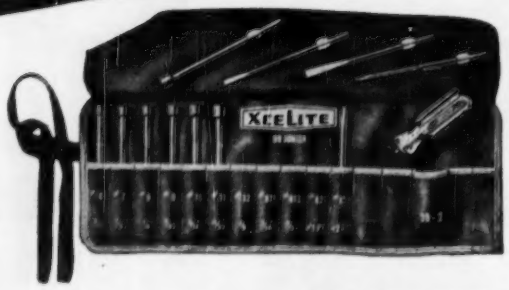
XCELITE Hand Tools
PREFERRED BY THE EXPERTS



No. 99 Junior Kit

IT'S THE MOST!

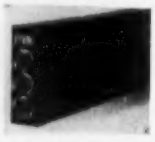
—MOST for your money
—MOST useful service kit
—MOST compact 11-tool pocket kit
—MOST popular since the "99"

Yes, since the 99 JUNIOR was introduced in May, technicians have kept us busy making enough! If you don't already have one of these pocket kits with the 7 quality XCELITE nut drivers and 4 screwdrivers, ask your supplier—they're in stock!

XCELITE, INCORPORATED
Dept. C
Orchard Park, N. Y.

For Originality LOOK TO XCELITE

Use "Unusable" Spaces with this
SUBMINIATURE
RECEIVER and POWER SUPPLY



Our Model 128 subminiature power supply (left) is designed to provide B + and filament voltages to various equipments. Being extremely compact (1" x 3" x 9") it may be mounted in inaccessible or normally unusable spaces. Lightweight (only 36 oz.), it has been ideal for critically balanced airborne devices. Consider it for your applications. The model 127 VHF receiver, as shown at right, incorporates modular design for flexibility of installation as one unit or separated for better space utilization. Wideband characteristics and module size (1" x 3" x 9") permit application in all fields of instrumentation and communication—airborne or otherwise. This receiver features crystal frequency control plus excellent sensitivity, quieting and noise rejection. Send the coupon below today for our Data Sheets 100 and 101 which give detailed specifications on this versatile equipment.

Land-Air Inc.
Instrument and Electronic Division
Oakland Int'l. Airport Oakland 14, Calif.
Subsidiary of California — Eastern Aviation, Inc.

Send me Data on your Subminiature Equipment:
Name .....
Address .....
City ..... State .....

1953 he served as a consultant to the FCC and the CAA.

Transistor Products also announced that Allen J. Dusalt, formerly semiconductor sales manager for CBS-Hytron, has been appointed general sales manager for Transistor Products.

Samuel Rubinovitz, formerly assistant to the director of sales, has been named government sales manager.

In Clevite's Brush Electronics Co., John H. Harris, formerly vice-president and general works manager, has been made vice-president in charge of planning, and Wallace T. Gray has been appointed general works manager.

Perry C. Smith has been appointed manager of the equipment department of Brush Electronics.

He joined Brush earlier this year. He was formerly general manager of the electronics instruments division of Burroughs Corp. Prior to that he was manager of scientific instruments engineering for RCA.

CBS-Hytron Builds Tenth Warehouse

CBS-HYTRON plans to build a 55,000 sq ft warehouse in Chicago for tubes. Completion is scheduled for early spring.

The new warehouse will have an engineering application laboratory, sales, service, and engineering offices, branding and packaging facilities.

The new structure will bring to ten the number of the firm's warehouses in operation.

General Mills Adds Five Engineers

L. K. LEE, former head of the advanced techniques laboratory at Stanford Research Institute, and George H. Geick of Emerson Radio, have joined the mechanical division of General Mills.

Lee, a specialist in miniaturization and automatic production techniques for electronics, will be technical advisor to the engineering research and development department. He will concentrate on design for automatic production.

Geick will be assistant manager

of systems analysis. He was assistant to the executive vice-president of Emerson, concerned with the administration of commercial and military design and production in radio, television and related fields.

Three German scientists have also joined the division.

Dr. Otmar M. Stuetzer has been named to head the electron physics lab. He was radar section chief of the German Research Council and coordinator of the German radar and countermeasures program during World War II. He comes to General Mills from the U. S. Air Force Wright Air Development Center at Dayton, Ohio, where he was chief of the advanced development branch in the electric components lab.

His staff will include Dr. Gottfried K. Wehner and Ludwig J. Mayer, who worked with him at WADC. Dr. Wehner, a specialist in gas discharge and surface physics, was a branch chief at Flugfunkforschungs, the German Air Radio and Radar Research Institute, during World War II. Mayer was chief of the microwave tube laboratory at the same establishment.

Telerad Elects New President

CHARLES GEORGE has been elected president and chairman of the board of Tetrad Manufacturing. George, who has served as vice-president and general manager for

Charles George

HOMELITE

will meet your specs for

LIGHTWEIGHT GENERATORS

Another Typical Homelite Example

To meet the requirements for lighter, smaller and more powerful auxiliary gasoline-engine-driven generators for both rotary and fixed wing aircraft, Homelite has designed and built several special units.

Typical of these new Homelite generators is the Model 34D28 shown above.

Weighing only 67 pounds . . . almost half the weight of previous auxiliaries with comparable power . . . this Homelite develops 70 amperes at 28.5 volts DC and is capable of starting 700 h.p. aircraft engines either directly or with a small battery floated on the line.

Requiring less than 3 cubic feet of storage space, this unit is equipped for push button or manual starting and starts without preheating in temperatures as low as minus 40 degrees Fahrenheit.

Meeting specifications for lightweight, powerful generators . . . for both military and commercial applications . . . is the specialty of the house with Homelite. We've been doing it for close to half a century.

No matter how new, how different or how tough your requirements . . . turn them over to Homelite. The chances are you'll get the most satisfactory answer . . . faster.

Write and our engineers will get in touch with you.

Homelite builds generators in sizes from .15KW up to 5KW in all voltages and frequencies... with either gasoline engine or electric motor drive.

Manufacturers of Homelite Carryable Pumps Generators • Blowers Chain Saws

PERFORMANCE · DEPENDABILITY · SERVICE

HOMELITE

A DIVISION OF TEXTRON AMERICAN, INC.

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PORT CHESTER, N. Y.

Canadian Distributors: Terry Machinery Co., Ltd., Toronto, Montreal, Vancouver, Ottawa

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IF IT'S NEW . . . IF IT'S NEWS . . . IT'S FROM ELCO

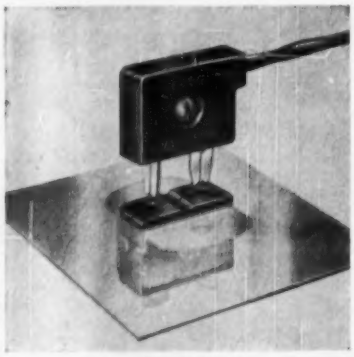


Figure A.

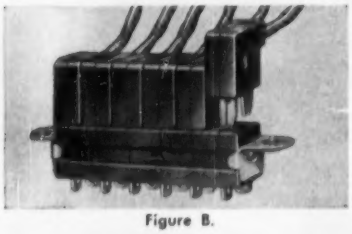


Figure B.

NEW RIGHT-ANGLE VARICON INTRODUCED

ELCO announces a new Right-Angle Varicon as the latest newsworthy addition to its world-famous line of miniature connectors. The new Right-Angle Varicon (Fig. A.) available in 2-contact male plugs, makes it possible to run wires or cable parallel to panel, thus conserving space. Units may be plugged into mating portion of connector, side by side. (Fig. B.).

Insulator acts as strain relief for cable, permitting exertion of heavy forces without breaking connections. Plugs are polarized the same as other standard Varicons; with the same high current and voltage rating, low resistance, low capacitance.

For further information, or a copy of the new Varicon Catalog V-2, please write us on your company letterhead.

ELCO CORPORATION, M STREET BELOW ERIE, PHILA. 24, PA., CU 9-5500

ALLIED CONTROL starts with the finest.....

Garfield Wire

When you specify Allied Control, you're asking for the best. For example, take the relay shown here. It's the finest there is — in split-second response, unfailing accuracy, rugged dependability.

Design — construction — materials — all have to be the best for Allied... and the heart of this relay is wound with Garfield Enameled Magnet Wire.

You'll start with the finest in wire, too, when you specify Garfield. Our modern drawing and enameling equipment, our rigid production control and our stringent inspection system are geared to produce only top-quality wire with tolerances closer than NEMA specifications.

Write for price lists and specification chart on Garfield bare wire, plain and heavy enamel additions today.

GARFIELD WIRE

GARFIELD WIRE DIVISION of The Anaconda Corporation

142 Monroe Street, Garfield, N. J., GRegory 2-3661-2

eight years, purchased controlling interest in the company.

Telerad has expanded its operations into the guided missile field and will manufacture beacons and guidance equipment in its new Flemington, N. J. plant.

Kinevox Purchased By Electromation

KINEVOX, of Burbank, Calif., manufacturer of synchronous magnetic recording equipment, has been purchased by the Electromation Co., an enterprise of F. Kirk Johnson of Fort Worth.

Kinevox will be a division of Electromation. A second division specializes in automation systems and components and a third division is responsible for the development and sale of Radad, a radiation exposure safety device which warns of dangerous radiation exposure.

C. A. Hisserich, as chief engineer, will direct research, development and engineering for Kinevox as well as the other two divisions. He will be aided by William C. B. Evans who will continue in his capacity of electronic engineer for Kinevox, and assume the duties of production engineer for Electromation.

Burroughs Research Appoints Two

ROBERT V. D. CAMPBELL has been named to fill the newly created office of deputy director at the Burroughs Corporation's research center. In this new position he will have responsibility for the line management of the research activity.

Prior to joining Burroughs, Campbell was a member of the staff of the equipment engineering division of Raytheon Manufacturing.

He joined the research activity of Burroughs in 1949 as supervisor in the planning department. In 1953 he became technical consultant on the technical planning staff and in 1954 he was named associate director.

Howell K. Fesq has been appointed manager of the administrative engineering department of

the special products division at the center. He has been staff engineer with Sperry Gyroscope, senior project engineer with Curtiss-Wright and administrative engineer of Simmonds Aerocessories. Prior to his present appointment he was contract engineer for Fairchild Aircraft Corp.

Eitel-McCullough Expands For Super Klystrons

A NEW 17,000 sq ft building with facilities for the production of super klystron amplifier tubes up to twenty feet long will be added to the main San Bruno, Calif., plant of Eitel-McCullough. Present plans call for completion of the building in early Spring.

According to the company, the need for additional klystron facilities arises from an increasing number of electronic applications, including forward-scatter.

One section of the building will include a two-ton crane to handle the giant klystrons.

The new extension will bring the total area at the main Eimac plant in San Bruno to approximately 170,000 sq ft.

Norden-Ketay Sets Western Division

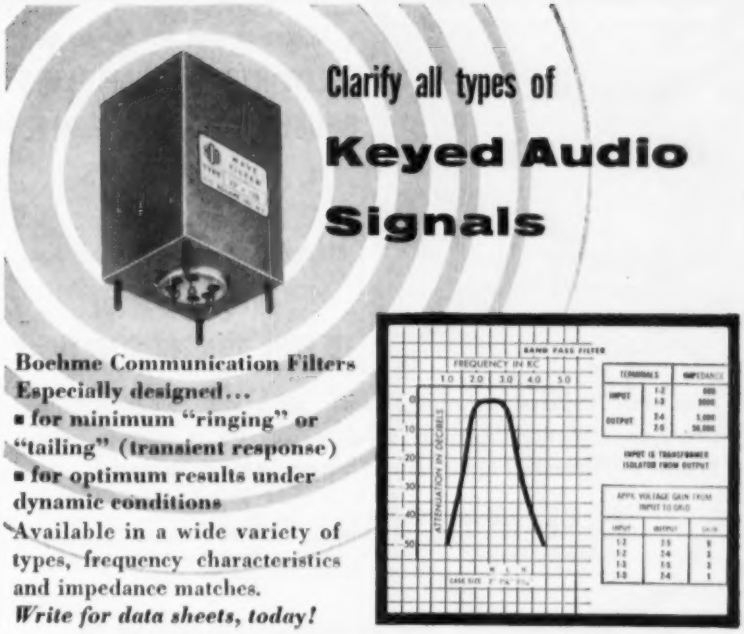
NORDEN-KETAY Corp. has established a Western Division in Gardena, Calif.

The division consists of two plants, one in Gardena, the other in nearby Hawthorne, Calif. Together the plants comprise a unit of 30,000 sq ft, equipped for research, design, development and quantity production of synchros and resolvers and other components.

General manager is Arnold Raines, who was previously assistant general manager of the Arga division of Beckman Instruments.

Manager of the engineering department is Herbert Galman, who was previously chief development engineer of Beckman's Arga division.

The division will have a research and development department under the direction of Harold H. Sarkissian. He was previously vice-presi-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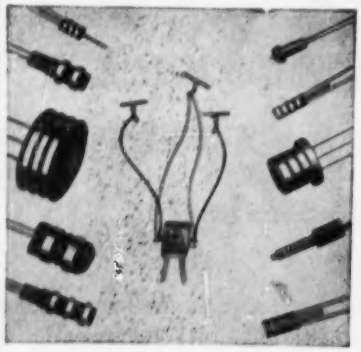

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dent and a member of the board of Computer Research Corp. and chief engineer of National Cash Register Co.

Norden-Ketay's present manufacturing operation in California, under Harry Loveman as operations manager, has been integrated into the new divisional organization.

Norden-Ketay also announced that George D. Butler has been appointed director of sales.

Before joining the firm, he was vice-president in charge of sales of Warren Electronics. Prior to that, he was district sales manager of Beckman Instruments.

During the war he was a project engineer at Bendix Aviation Corp., and also senior engineer at Carl L. Norden in New York.

Tracerlab Builds New Plant

CONSTRUCTION has been started by Tracerlab on a new 164,000 sq ft plant in Waltham, Mass.

The new plant will be ready in the Summer of 1956. Tracerlab's operations have grown from $30,000 in 1946 to over $12,000,000 in 1954.

The new plant will also house certain operations of Keleket X-Ray Corp., a Tracerlab subsidiary.

Erie Resistor Promotes Foster

JAMES H. FOSTER has been appointed general manager of Erie Resistor's electro-mechanical division. Since joining the firm five

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years ago he has served as chief of electronic research and assistant general manager of the division he now heads.

New Firm Formed By RC Controls

COMPUTER-MEASUREMENTS division of Detectron Corp. has been acquired by RC Controls Corp. of North Hollywood and formed into a new company to be known as Computer-Measurements Corp. The firm has a new plant in North Hollywood, Calif. Development, design, manufacturing and sales will take place there under John K. Rondou, president and J. L. Cassingham, vice-president.

Baldwin-Lima Elects Three V-Ps

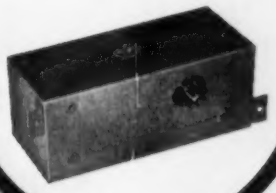
ROBERT B. MURRAY, JR., former Undersecretary of Commerce, has been promoted to vice-president and has been elected a member of the board of directors of Baldwin-Lima-Hamilton Corp. He has been assistant to the B-L-H president since leaving his government post.

James M. White has been elected vice-president in charge of manufacturing for B-L-H, resigning a similar post at ACF Industries to accept the new position. He formerly also was manufacturing vice-president for Allis-Chalmers.

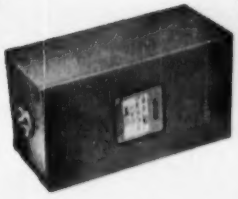
Colonel John R. Martin, who recently retired from the U. S. Air Force as director of procurement for the Air Research and Development Command at Baltimore, Maryland, has been appointed vice-president in charge of electronics and instrumentation operations.

U. S. Officials Honor Canada's Browne

IN CANADA, the Department of Transport's retired controller of telecommunications, G. C. W. Browne was presented with a scroll and a wrist watch from his friends and acquaintances in Washington, D. C. The presentation was made on behalf of U. S. officials in the communications field of the State Department, Military Services, Coast Guard, CAA, FCC, the



HYCOR TELEMETERING FILTERS



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Department of Agriculture and the Department of the Interior.

Previously RETMA of Canada and the Department of Transport had honored him.

Moloney Electric Promotes Two

C. M. LOVELL, formerly vice-president and chief engineer of Moloney Electric, transformer manufacturer, has now been named vice-president in charge of engineering and research.

He joined the firm in 1920 as an engineer. He was made chief engineer in 1928. In 1942, he was appointed as vice-president and he was also elected to the board of directors.

Lovell has been instrumental in the development of concentric-layer winding and its application to transformer manufacture at Moloney.

The company also announced that David F. Winter has been appointed vice-president, chief engineer and director of research. He will continue in his recently-appointed post as director of the newly-formed engineering research and development laboratory of Moloney Electric.

He has served as a staff member at the radiation laboratory of MIT.

In 1948 he joined the staff of Washington University as an assistant professor of electrical engi-

C. M. Lovell

D. F. Winter

neering.

On leave of absence, Winter joined the DuMont Laboratories as a senior engineer and then as an engineering consultant to the instrument division in 1949. From 1950 to 1952 he served first as a senior engineer under special contract with the Naval Ordinance Plant at Indianapolis, Indiana, and then as project head.

In 1951, Winter was made an associate professor at Washington University in St. Louis. He came with Moloney Electric in 1952 as a consultant.

In 1954, Winter joined Moloney on a full time basis with a leave of absence from Washington University.

Winter received a full professorship at Washington University in 1955 and is now an affiliate professor with that institution.

Tharpe Leaves Du Mont, Petersen Named

JAMES B. THARPE has joined Visual Electronics Corp., of New York as president.

He resigns as manager of the Du Mont television transmitter sales department to associate himself with the independent selling agents representing Du Mont in the sale of TV broadcast equipment. He will directly handle all New York City and network accounts, and, in conjunction with Herbert Bloomberg, will handle key

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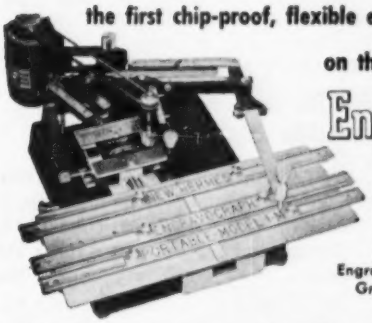

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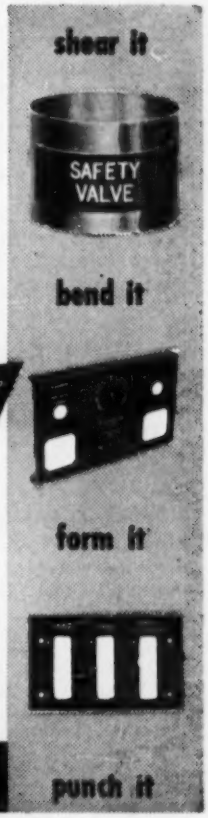

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television broadcast equipment accounts in the area between New York and Chicago.

Kenneth F. Petersen succeeds Tharpe at Du Mont. He was formerly marketing manager for Du Mont tv transmitter sales and before that director of engineering facilities for WPIX in New York.

Alto Scientific Adds Engineers

PRINCIPALS of the Alto Scientific Co. now include president Lester L. Libby, vice-president Thomas F. Turner and secretary-treasurer Dr. David D. Cherry. Together, the background of the trio includes experience in development, manufacturing or sales with Tung Sol, Federal Telegraph Co., Federal Telephone and Radio Corp., Kay Electric, Ohmega Laboratories, Civil Aeronautics Administration, Northrop Aircraft Co., Sierra Electronic Corp. and Bell Telephone Laboratories.

New engineers joining Alto recently include James F. Melton, formerly with the Stanford Research Institute and Hewlett-Packard Co., Lawrence R. Teeple of California Research & Development and Consolidated Aircraft, and Kenneth A. McQueeney who came to Alto from Sierra Electronic Corp.

New Glass Seal Company Established

W. P. SPEER, formerly manager of the glass seal division of Cannon Electric, has organized Seals, Ltd. in South Pasadena, Calif.

The company specializes in the design, manufacture and sale of glass-seal type connectors.

Summers Gyro Appoints Romig

HARRY G. ROMIG has been appointed staff engineer at Summers Gyroscope Co.

He comes to the Santa Monica concern with 30 years of varied experience in industry. Twenty-

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- Dekatron direct-reading counting and timing tubes
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- Dual-range Power Supply—250-1000 and 500-2000 volts

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five of these years he was with Bell Telephone Laboratories, New York, N. Y., as a member of the technical staff specializing in quality control. He was with Hughes Aircraft Co., Culver City, Calif., for almost three years, serving ultimately as technical director of quality control after being quality manager of central quality control. Recently, in addition to consultant work, he was employed by International Telemetering Corp., Los Angeles, as quality director.

Midwestern Elects New President

G. R. MORROW, vice-president and manager of Midwestern Instruments, has been elected president.

M. E. Morrow, founder and president, became chairman of the board.

E. J. Handly was elected vice-president of finance. Other re-elected officers were D. G. O'Brien, vice-president in charge of engineering and production; A. E. McCoy, vice-president in charge of sales; John F. Y. Stambaugh, secretary-treasurer and Truman R. Howell, assistant secretary-treasurer and comptroller.

The company now occupies its new million dollar plant in Tulsa, Okla.

NBS Appoints Parts Chief

ROBERT D. ELBOURN has been appointed chief of the components and techniques section of the National Bureau of Standards. This section investigates new components and devices for electronic computers and explores techniques for applying them.

Elbourn is a member of the original team that developed in 1950 the Bureau's electronic computer, SEAC.

He has been with the Bureau since 1947.

Prior to joining the Bureau's staff, he was an electronic engineer with the Naval Ordnance Laboratory and with C. G. Conn of Elkhart, Ind.

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New Books

Elements of Electronics

By Henry V. Hickey and William M. Villines. *McGraw Hill Book Co., New York*, 1955, 487 *p*, $5.00.

In this volume the authors get right down to business; they introduce the vacuum tube soon after describing the basic behavior of the electron. This may seem an unconventional approach, but it steers the beginner immediately to the most important electronic device with which he is to become intimately acquainted. To make the story particularly pertinent in the first chapter, the explanation of direct currents and static electricity are immediately entered together with a brief introduction to mathematics involving the power of ten.

A-C and D-C Circuits

The principles and operation of simple d-c circuits, natural and electromagnetism plus a working knowledge of meters, follow in simple logical sequence.

Alternating-current theory is treated with sufficient detail and is accompanied by two chapters, one on trigonometry and one on phase relationships; these three chapters adequately fill out the picture on a-c fundamentals with a minimum of confusion.

The action of capacitive and inductive circuits as described in the following two chapters are relatively simple since the reader has first been given a background in alternating-current theory.

Electron Devices

The remainder of the volume deals with vacuum tubes and their application to electronic equipment. The primary vacuum-tube functions of amplification and oscillation, are covered in six chapters, five of which are devoted to types of amplifiers. The relationship of the basic electronic functions to concrete operating equipment is covered in ten chapters—five on transmitter theory and operation—five on receivers.

A short chapter on transistors follows, to end the book rather abruptly.

Granted that receivers and trans-

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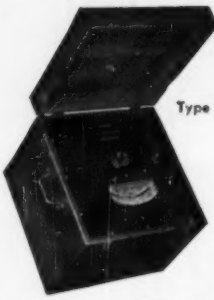

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mitters form the major portion of electronic gear, it would have been pertinent to round out the volume with a few pages more on electronic circuitry as applied to control, measurement, photoelectricity and television.

On the whole, the book gives a well planned and clear explanation of electronic principles. Circuit functioning and practical commercial applications are covered with excellent technique.

Enough restraint has been exercised in the descriptive matter to give a clear picture without letting the text become confused with redundant material.

HARRY E. THOMAS, *Senior Project Engineer, Federal Telecommunication Laboratories, Nutley, N. J.*

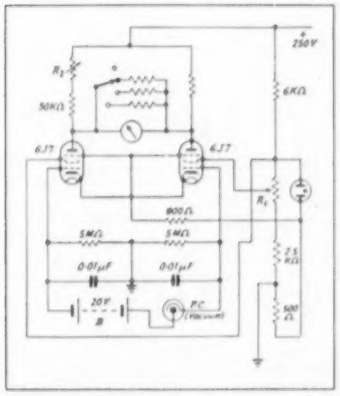
Electronic Measuring Instruments

By E. H. BANNER. *The Macmillan Co., New York*, 1955, 395 *p*, $8.50.

INTENDED primarily for the information of instrumentation engineers, this book is neither a text nor a handbook. It covers basic theory of electronic devices useful in instrumentation and their application. The instruments described include industrial, scientific and medical instruments. Electronic test equipment is not covered in this book.

Arrangement

The book is presented in three parts. The first discusses eletronic devices such as vacuum and gas-filled tubes, cathode-ray tubes,



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phototubes, solid-state devices and particle detectors.

Part two discusses electronic measuring instruments making use of these devices. Part three covers other measuring instruments including electronic and other counters, electromechanical transducers, electrical instruments and instruments for measuring physical quantities.

Usefulness of the book to American engineers is somewhat limited in that many of the electron tubes and commercially available instruments described are, understandably, of British origin.

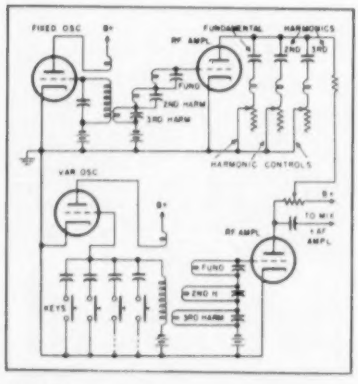
Striking a humorous note in the preface, the author suggests that thermopiles might have been used at Thermopylae or that diodes and triodes are extensions of the Odes of Horace.—J.M.C.

Electronic Musical Instruments

By RICHARD H. DORF. *Radio Magazines, Inc., Mineola, New York,* 1955, 326 *p,* $7.50.

THAT THERE is a need for a book covering the field of Electronic Musical Instruments is obvious since there have been so many new and interesting applications of electronic (and electric) devices to the music world. The book "Electronic Musical Instruments" does describe most of the innovations currently on the market.

It is apparently written for three groups: the musician, the engineer-technician, and the build-it-yourself enthusiast. As a result—interested musicians find it lacking since



Heterodyne instrument with harmonic synthesis

it does not delve into the musical aspects of the subject in sufficient detail. The engineer-technician finds many instances where subjects are excessively simplified, and the build-it-yourself enthusiast finds not enough detail to permit finished construction.

Further, a speaking-to-class presentation is used rather than a less verbose and more professional writing technique. The book is well illustrated with pictures showing the various instruments, and schematic drawings are used profusely and advantageously for greater clarity. The book is well printed with exceptionally few typographical errors. The appendix of electronic music patents is quite extensive.

G. EDWARD HAMILTON, *American Broadcasting Company, New York, N. Y.*

Thumbnail Reviews

The Mobile Manual for Radio Amateurs. American Radio Relay League, West Hartford, Conn., 1955, 352 p, $2.50 (paper). Selected articles from *QST* dealing with design of station equipment for mobile operation. Articles described receivers, transmitters, antennas and power supplies.

Basic Synchros and Servomechanisms. Van Valkenburg, Nooger & Neville, Inc. John F. Rider Publisher, Inc., New York, 1955, two volumes: 272 p, $5.50 (paper), $6.95 (cloth, one volume). Material from Navy course on Basic Synchros and Servomechanisms. Pictorial presentation, quite elementary. Covers servo components, servo fundamentals and design, error detectors, amplifiers and control circuits.

Handbook of Engineering Materials. D. F. Miner and J. B. Seastone. John Wiley & Sons, Inc., New York, 1955, 1,391 p, $17.50. Includes sections on general information about materials, metals, nonmetals and construction materials. Covers common chassis metals, papers, fibers, plastics and rubbers, organic finishes, carbon products and ceramics.

Proceedings of the First Conference on Training Personnel for the Computing Machine Field. A. W. Jacobson. Wayne University Press, Detroit, Mich., 1955, 104 p. Proceedings of a conference held at Wayne University June 22-23, 1954. Includes 17 papers, reports on 3 panel discussions and roster of persons attending conference. Subject headings include: manpower requirements, educational programs, influence of computers on technical and general education and cooperative efforts for training and research.

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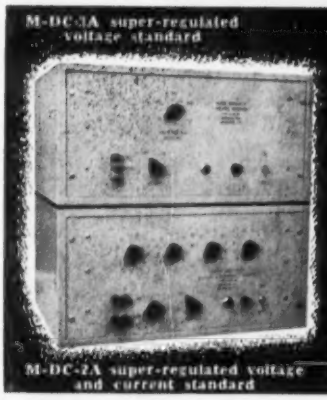

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Backtalk

Resistance Analyzer

DEAR SIRS:

WE BELIEVE you will be interested in knowing that your printer must have dropped one or two lines of type when making the break in that story between pages 290 and 292, September 1955.

The last sentence on page 290 should have read: "It was designed to check such characteristics as d-c resistance, temperature coefficient, and voltage coefficient of resistors according to JAN specifications. Voltage coefficient of any resistor up to a capacity of 2 w can be determined down to as low as 0.0002 percent per volt."

RICHARD G. MORRIS
Manager
Advertising, Public Relations
The Kuljian Corporation
Philadelphia, Pennsylvania

Patent Examiners Needed

DEAR SIRS:

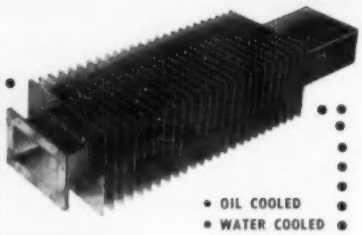
THERE is a serious delay in the processing of patent applications in the U. S. Patent Office because the size of the examining staff has not kept pace with the increased number of patent applications filed. This creates uncertainty as to the patent status of new products and processes and tends to slow down or defer their adoption by industry and their introduction to the public.

This is a matter that can handicap the larger corporation and can be critical for the individual inventor and the small business whose operations revolve around patented products and processes.

Congress has appropriated additional funds for new patent examiners, but with the existing demand for engineers and scientists in industry it has been difficult to obtain enough candidates having the necessary technical qualifications . . .

There are vacancies in the examining staff which should be filled promptly this fall and we appeal to you . . . since ELECTRONICS is read by the technically and scientifically trained people whom the Patent Office is trying to reach.

Steps have already been taken



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in this direction and over 100 new patent examiners have been added to the examining staff since June of this year, and it is understood that the Patent Office plans to build this number up to a total of 350 new examiners by the end of 1956 . . .

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HENRY E. SHARPE
The New York Patent Law Assoc.
New York, N. Y.

Face-Plate Seal

DEAR SIRS:

THE STATEMENT in the news story on p 22 (Nov. 1955) that "a low temperature solder glass seal is used to seal the face plate to the funnel . . ." is incorrect. The face plate and cone of the all-glass color television tube are sealed by the same method used regularly to seal the face plate and cone of black and white television tubes.

H. C. MCDANIEL
Westinghouse Electric Corp.
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Transistor Symbol

DEAR SIRS:

I HAVE found it quite convenient and, I believe, also appropriate to use the symbol *XR* to indicate or label a transistor in schematic diagrams and as an abbreviation in written material.

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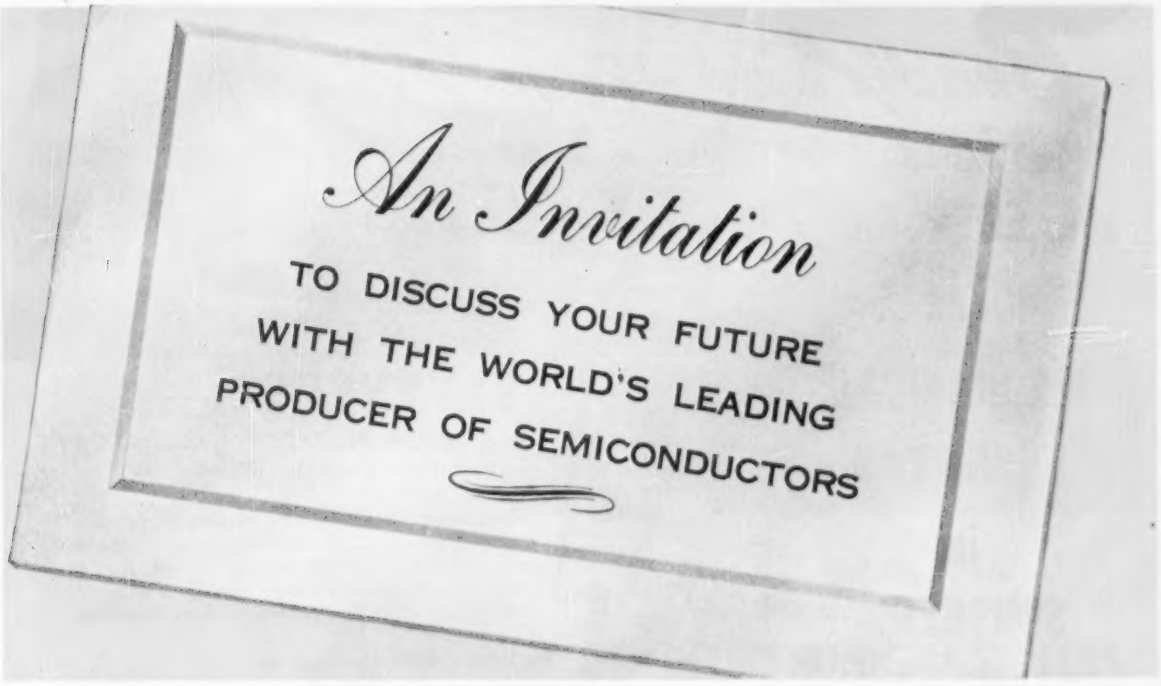

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		Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
		1-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
SYSTEMS *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*													
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DIGITAL DATA HANDLING DEVICES	M C			C			C			C			
MISSILE ELECTRONICS • RADAR	M			M X			M			M			
INERTIAL NAVIGATION	M			M			M			M			
COMMUNICATIONS				C I						C I			
DESIGN • DEVELOPMENT													
KINESCOPES (B & W and COLOR), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)		L	L	L	L	L	L	L	L	L	L	L	L
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development		H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials		H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)	H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing		L	L	L	L	L	L	L	L	L	L	L	L
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization	M C	M C X	M C X	M C X	M C	M C X	M C X	M C X	M C X	M C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming		C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control	M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS — Microwave — Aviation — Specialized Military Systems		C	C	C		C	C		C	C			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		I	I	I		I	I		I	I			
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms	M	M	M	M	M	M	M	M	M	M			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors		C	Z C	Z C	C	Z C	Z C	C	C	C		Z	Z
MACHINE DESIGN Mechanical and Electrical—Automatic or Semi-Automatic Machines			L	L		L H	C L H		L	L			

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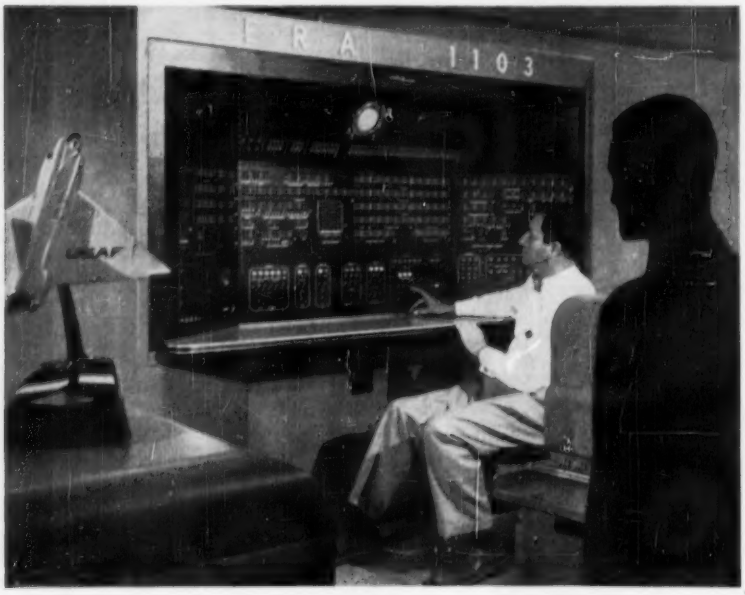

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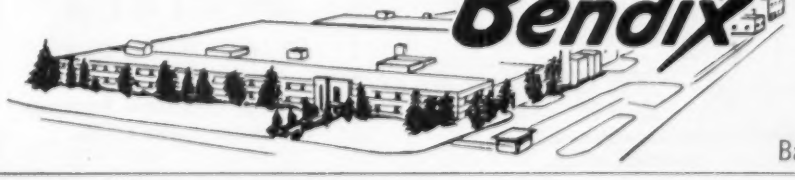

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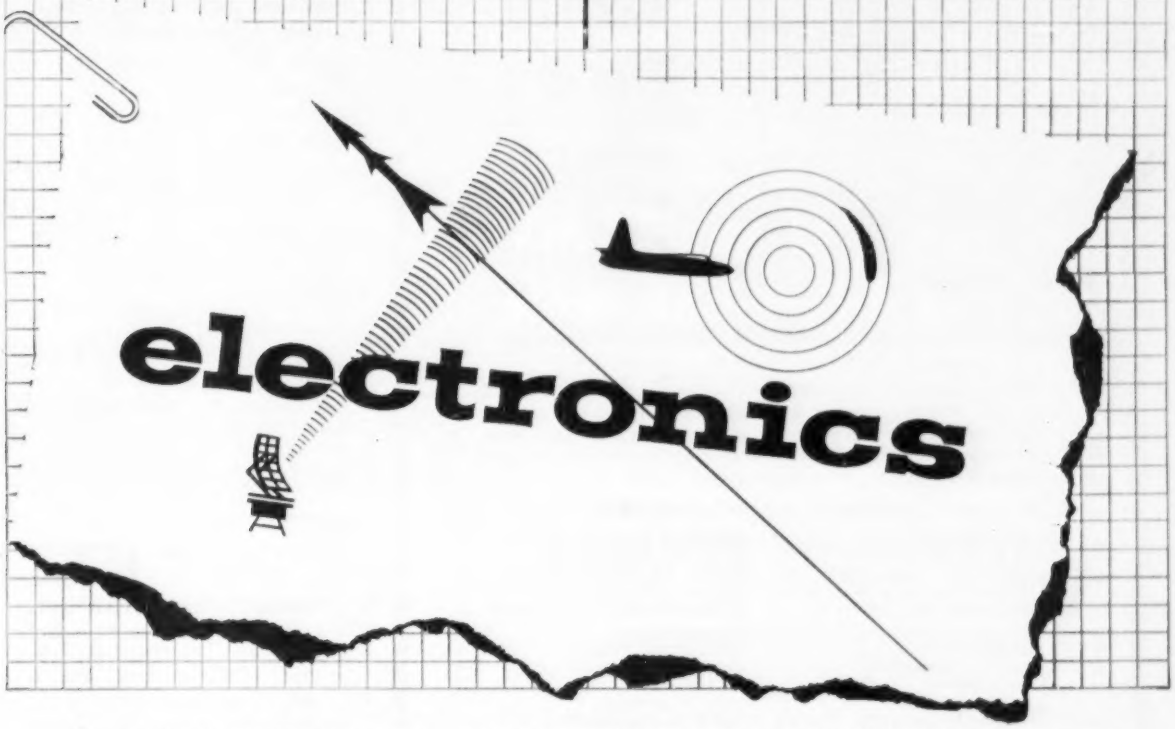

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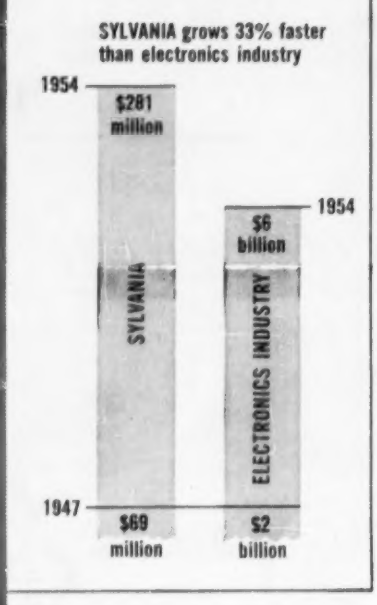

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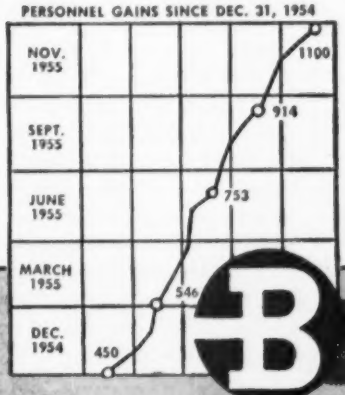

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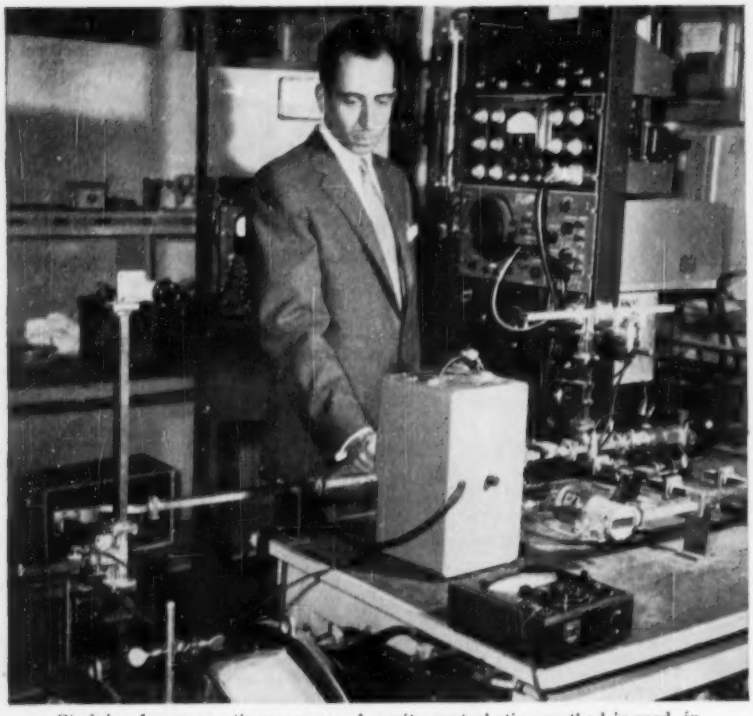

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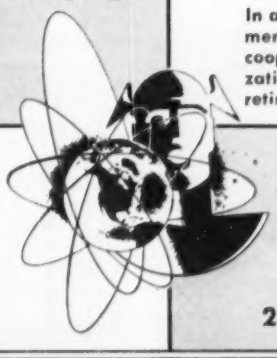

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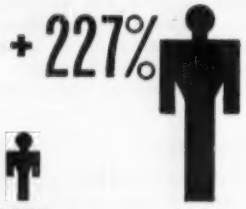

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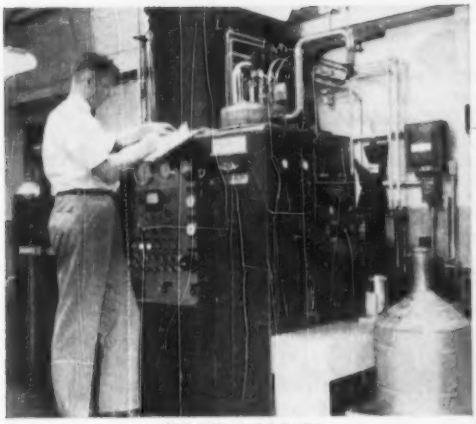

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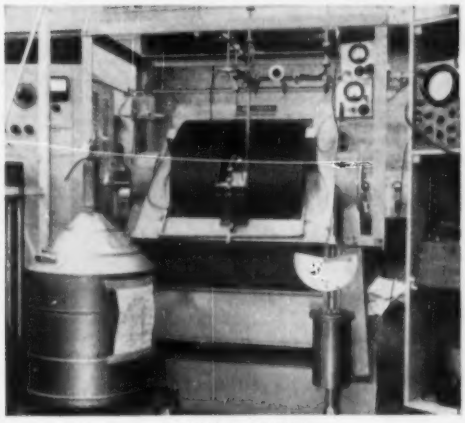

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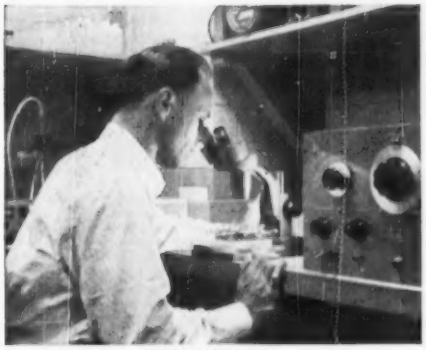

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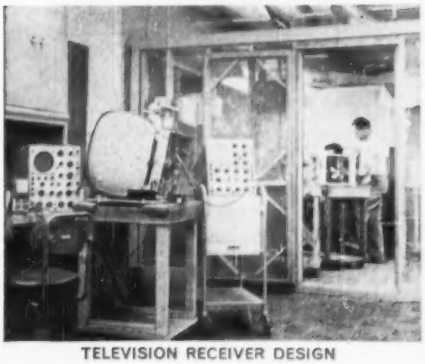

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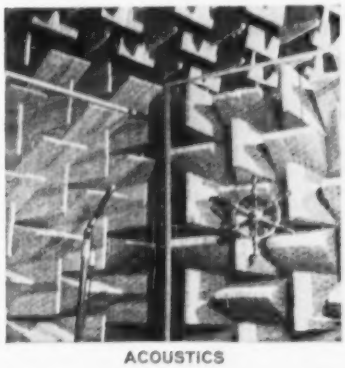

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Employment Opportunities ADVERTISERS INDEX

Armour Research Foundation of Ill. Inst. of Tech. 398
Admiral Corp. 403
Arma Division
American Bosch Arma Corp. . . 396, 398, 404
American Machine & Foundry Co. 404
AVCO Mfg Corp.
Crosley Division 398
Avion Division of ACF Industries Inc. 411

Bendix Aviation Corp.,
Pacific Division 384
Products Division, Missile Section 395
Radio Division 389
Research Laboratories 412
York Division 403
Bonder-Tongue Labs. 394
Brown Instruments Div., Honeywell 390
Burroughs Research Center 393

Calidyne Co., The 410
Cardwell Electronics Prod. Corp., Allen D. . 411
Communication Accessories Co. 400
Computer-Measurements Corp. 402
Convair, A Div. of General Dynamics Corp.
San Diego, Calif. 388
Pomona, Calif. 401

Decision Inc. 407
Drake Personnel Inc. 388
Dynamic Electronics NY, Inc. 394

Electric Boat Div.
General Dynamics Corp. 404
Electronic Engineering Co. of Calif. 408
ERCO Div., of ACF Industries 407

Farnsworth Electronics Co. 400
Fisher Radio Corp. 404

General Electric Co. 396, 405
General Motors Corp.
AC Spark Plug Electronics Div. 394
General Precision Lab. Inc. 411
Goodyear Aircraft Corp. 391

Instruments for Industry Inc. 402

Jet Propulsion Lab.,
Calif Institute of Tech. 411
Johns Hopkins University, Applied Physics Inc. 407

Kollsman Instrument Corp. 408

Land-Air Inc. 402

Maryland Electronic Mfg Corp. 392
Melpar Inc. 409
Monarch Personnel 388

National Carbon Co. 403
National Employment Service 388

Olin Mathieson Chemical Corp. 400

Page Communications Engineers 396
Phillips Petroleum Co. 406

Radio Corp. of America 386, 387
Radio Receptor 409
Raytheon Mfg Co.
Missile and Radar Div. 390
Waltham, Mass. 396, 405
Newton, Mass. 410
Remington Rand, Div. of Sperry Rand Corp., Engineering Research Assoc., Div. 385
Remington Rand Univac Div. of Sperry Rand Corp. 397, 401

Sanders Assoc., Inc. 409
Sikorsky Aircraft 412
Sorensen & Co., Inc. 398
Snyder Co., Lee Grant 388
Stavid Engineering Inc. 405
Stromberg-Carlson Co.,
Div. of General Dynamics 407
Sylvania Electric Products Inc.,
Buffalo, N. Y. 392
Waltham, Mass. 392
Mountain View, Calif. 384

Technical Operations 394
Tracerlab., Inc. 409
Transitron Electronic Sales Corp. 383

Vitro Corp. 406

Zenith Radio Corp. 399

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INDEX TO THE SEARCHLIGHT SECTION ADVERTISERS

Allied Electronics Sales 418
Alltronics 422
Amber Industrial Corp 413
American College of Engineering 413
Arch Electronics Co 418
Arrow Sales Inc 424

Barry Electronics Corp 425
B & C Distributors Co 413
Belevision Inc. 422
Blan 416

Cagan Sales, R. C 422
Chase Electronic Supply Co 426
C & H Sales 423
Communication Devices Co 416
Communications Equipment Co 421
Compass Electronics Supply Div., of Compass Communications Corp 426
Cramer Electronics Inc 424

Electronicraft Inc. 427
Empire Electronics Co 424
Engineering Associates 418

Delaware Equipment Co 412

Fair Radio Sales 414
Fay-Bill Distributing Co 420
Finnegan, H. 413

Gould Green 414
Greene, G. 413

Harjo Sales Co 416
Hodgson Co., R. W 413
Houde Supply Co 424

Instrument Service Corp 422

JSH Sales Co 417

Lapirow Bros. 422
Lectronic Research Labs 412
Legri S. Co., Inc 416
Liberty Electronics Inc 427
L & M Associates 422

Magnetran Salvage Co 413
McNeal Electronic & Eqpt. Co 416
Mogull Co., A 426
M. R. Co., The 424

Radalab 414
Radio & Electronic Surplus 424
Robinette Co., W. C 413
Red Arrow Electronic Sales Co 413
Relay Sales 420
Rex Radio Supply Co 414
Ruxur Electronics Corp 425

Sanett, Bob 413
Semler Industries Inc 422
Societe Industrielle Alfa, S. A 412
S. & R. Electronics Inc 426

"TAB" 415
Telemarine Communications Co 418

Universal General Corp 424

V & H Radio & Electronics Supply 422

Western Engineers 419
Wilgreen Industries 420

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(Continued on pages 413-427)

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Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v 60 cyc.

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Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.W. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

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VC 7" P.P.I. Upright deck mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VD 7" P.P.I. Deck mount Repeater. This unit is very similar to the VC but is completely Waterproof and may be used on deck. The ranges are the same as the VC. Input 110 Volt 60 Cyc.

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VF 9" P.P.I. Deck mount Repeater. This is a very late model Repeater enabling 20 radars to be fed into it. 4 Ranges from 4-200 miles are provided. Input 110 Volt 60 Cyc.

VG 12" P.P.I. Plotting Table Projection Repeater. This is a very elaborate Remote Indicator. For use in a plotting center. Up to 20 Radars may be fed into it. This set utilizes a Skiatron tube to provide data that can be retained on the screen and can be erased at will. Input 110 volt 60 Cyc.

Accessories are available such as repeater adaptors enabling the set to be used at a greater distance than normal. Input switches to select the radar to be viewed etc.

SCR-682-A RADAR

10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225 KW, pulse width is one microsecond. Antenna beam width is 9°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

We can supply many types of radars, test sets, communications equipments, manufactured after 1947. Write us if you cannot find it.

AN/APR-4 38-4000 MC RECEIVER

This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30mc. I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR.

500-1300 MC SIGNAL GENERATOR

This is a high precision signal generator covering 500-1300 mc. A precision attenuator is built in providing accurate determination of output from 0-100,000 microvolts. Either CW or pulsed carrier output with the following characteristics are provided. Pulse rate 60-2,500 CPS. Pulse length 2-30 microseconds. Output line 50 Ohm impedance. Accuracy better than one percent. Input 110 v 60 cyc. With calibration charts. Price $249.50

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AN/CPN-8 S-BAND HIGH POWER Airport Beacon. This is a very compact set. This set will interrogate S-BAND Radars up to 200 Miles. Variable Coding and monitoring facilities are provided. Input 110 Volt 60 Cyc.

AN/CPN-17 S-BAND High power version of the CPN-6 with all the latest improvements. Input 110 Volt 60 Cyc.

AN/UPN-4 X-BAND Very lightweight Portable Beacon. This set will interogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight approx. 40 Lbs.

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Tubular steel, copper coated, painted—in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section....@ 50¢ Each. Larger Dia. Section MS-54 75¢ Ea.

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12 or 24	230	100	DA-12		8.95
12 or 24	540	450	DA-14		14.95
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24	250	60	PE-86		9.95
14 VDC	330	150	BD-87	3.95	5.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
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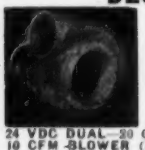
12 or 24	275	110	USA/0516		4.95
12	230	90	PE-133	4.95	6.95
14 VDC	375	150	BD-83	3.95	4.95
12 VDC	220	80	DM-4	3.95	4.95

BLOWERS:



12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 2" intake; 2" outlet, Shunt Motor 4"x3" 2000 RPM @ 24 VDC..$5.95

6 VDC SINGLE—100 CFM—No. 6100 ..... $4.95

6 VDC FLANGE—150 CFM—No. 6150 ..... $6.95

24 VDC DUAL—30 CFM—Min—No. 2420..... $7.95

10 CFM BLOWER (Pictured—right) 27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #3, overall size: 2-½" x 4-½". Price $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R. #3 Blower Assy. Overall size: 4-½" x 3-½". No. 2110....$5.95

10 CFM BLOWER (Pictured at left)—24 VDC—.6 A; 5000 RPM. Pioneer Motor S8S-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-½". Price $5.95

115 V. 60 CYCLE BLOWERS:

115-VAC 60 cycle SINGLE TYPE—100 CFM: 2-¾" intake: 2" outlet. Complete size: 5" x 6" —No. 1C939 ..... **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake: 2" Dia. Each side. Complete size: 8" x 6" —No. 1C880 ..... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside quirrel cage; 4-½" intake; 3⅝" x 3" Dia. Complete size: 4-½" W x 8-⅝" H x 8-¼" D—No. 2C967 ..... **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM: 3-¼" intake; 2-½" Dia. Complete size: 7-½" W x 7-¼" H x 8-⅝" D—No. 1C807 ..... **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM: 4-¼" intake; 3-¼" x 3" Dia. Complete size: 11-⅝" W x 8-⅝" H x 8-1/16" D— No. 3C069 ..... **$21.95**

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 2" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NBI-33. Removed from New Equipment. #BOD-200 ..... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-⅝" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**
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1.08	300	2050	8000	51000	300000
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3	350	2187	8200	55000	318000
3.83	360	2195	8500	56000	325000
4	380	2300	8770	57085	330000
5	420 .9	2260	9100	60000	350000
7	480	2300	9500	61430	360000
7.8	470	2400	10000	62000	375000
8	500	2560	10500	64000	380000
10.50	530	2700	11000	68000	390000
10	540	2700	11500	70000	400000
14	560	2880	12000	80000	420000
15	570	3000	12500	82000	430000
17	580	3000	13000	84000	450000
20	620	3290	14000	85000	450000
25	750	3450	15000	86000	460000
26	800	3333	15000	90000	470000
28	820	3500	16000	91000	478000
30	850	3800	16500	95000	500000
48	910	3730	18000	98000	510000
50	917	3760	19000	100000	520000
61.78	978	3900	20000	110000	540000
61	1000	4000	21500	120000	550000
68	1068	4230	22000	130000	560000
70	1080	4300	23000	135000	570000
68	1116	4440	24000	140000	575000
74	1200	4800	25000	150000	600000
76	1225	4700	26000	160000	650000
82	1260	4900	27000	169000	680000
95	1300	5000	28000	175000	690000
100	1400	5100	29000	180000	700000
110	1500	5600	29990	190000	7500000
120	1518	5730	30000	200000	800000
130	1580	6000	31000	210000	850000
140	1640	6000	32000	215000	8200000
154	1800	6100	35000	220000	850000
160	1800	6200	35000	230000	900000
180	1892	6300	36000	239000	910000
200	1900	6400	37000	250000	930000
210	1904	6600	38000	260000	950000

MEGOHMS

1	1.5	1.8	2.5	3.5	12
1.1	1.57	2	3	4	15 .02
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1.35	1.74	2.5	3.9	7	10 13.55
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10 of One Value . . . . . ea **10¢**
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10 Assorted Values **$1.50**

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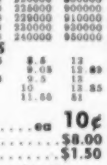
6KV DC & AC
27 Range
MULTITESTER
(Not a Kit)



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IN LOTS OF 3

A complete precision test instrument. 20,000 Ohms per Volt DC, 10,000 Ohms p/v AC. 3½ microamperes movement. 8 easy to read scales—DC 0-5, 10, 50, 250, 500, 1200, 6000 Volts. AC 0-5 10, 50, 250, 500, 1200, 6000 Volts. Currents 0-50 µa, 500 µa, 5 ma, 50 ma, 500 ma. Resistance 0-5K, 50K, 500K, 5 megohms. Decibles Cal 500 ohm —20 to +6, 20, 34, 46, 60 DBs. Capacity 250 to 0.1 mfd. Inductance 20 to 1000 millihrs. Hi accuracy, versatile, 1% Precision Resistors. Scale 3" Plastic engraved panel. Rugged metal case. Size 5¼x7¼x3¼". Complete w/batteries & leads. Shpg. wt. 4 lbs.
"TAB" SPECIAL . . . . . @ $22.95 ea.
HV PROBE, 10,000 Volts . . . . . @ $5.95 ea.

TUBES
1st Quality

0A2	.5	.74	304TL	12.95	5722		6.39
0A3		.98	316A	.48	5725		1.77
0B2		.98	394A	1.20	5727		1.77
0B3/VR90		.54	394A	1.20	5736		150.00
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VR105		.82	446B	3.96	5749		2.72
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VR150		.78	502AX	1.35	5750		1.09
1AD4		3.95	512AX	1.35	5751		1.09
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1AH4		1.35			5768		6.50
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1E37		2.07	723AB	9.98	5842		12.00
1E43		1.40	724A	2.94	5844		6.48
1E45		1.40	724B	2.94	5852		7.57
1J42		98.50	725A	4.49	5857		59.50
1K25		23.50	807	1.19	5861		49.95
1K29		27.95	807W	1.98	5863		49.95
1K29		27.95			CK5875		2.06
1K30		130.00	814	3.48	5876		12.95
1K32		219.48	815	3.98	5879		1.59
			829B	8.49	5881		2.79
2K41		175.00	832A	5.49	5886		1.98
2K42		149.95	837	.74	5892		1.98
2K43		149.95	927	1.76	5894		1.98
2K48		110.00	954	.38	5910		.74
2K50		215.00	955	.32	5930		6.45
2K51		298.00	956	.32	5998		97.25
3B24W		8.48			6021		1.98
3C22		72.50	CK1005	.46	6027		179.95
3C24		3.98	1612	1.98	6072		1.98
3D21A		7.99	1613	1.98	6080		1.98
			1616	1.79	6099		1.98
4-65A		19.49	1619	.34	6101		1.98
4-125A		49.50	1623	.46	6111		1.98
4B23		16.98	1625	.44	CK6111		6.35
4B24		4.98	1626	.36			
4B27		4.98	1628	.34			
4C35		.74	1629	.32	6119		6.45
4J36		79.95	1632	.48	6121		9.00
4J38		99.95			GL6136		1.89
4J50		98.50			6145		1.98
4J52		445.95	1633	.98	6146		4.98
4X150A		36.00	1642	.42	6164		64.95
			1644A	99.00	6169		49.95
5C22		29.98	1654	.34	6170		159.95
5D21		9.48	2050W	2.48	6171		159.95
5U4G		.46	5514	4.48	6172		159.95
5V4G		1.50	5515	.46	6173		159.95
5AS6		1.68	5517	1.50	6905		4.97
5AS7G		2.98	5518	2.22	6907		1.89
5B/		.98			6913		4.91
5BP1		.74			6914		1.98
5SN7		.55	5586	159.78	6916A		59.50
5V4GT		.45	5587	159.78	6920		1.98
5V4GT		.36	5640	7.50	6972A		7.99
6X4		.42	5640	11.57	7001		4.98
			5641	8.50	7003		1.98
6D21		99.00	5642	8.59	9002		.98
12AU7		.54	5643	.98	9003		.98
12AV7		.54	5654	1.72			
12BH7		.74	5670	1.98			
PG37		3.01	5693	1.98	C-Ray Tubes		
19BG6		1.98	5670	2.34	3CP1A		6.45
20P1		1.98			3CP1B1		6.98
20P3		1.98			3DP1		6.98
HH24		4.00	5672	1.55	3DP1A		6.00
35Z5		.46	5686	1.98	3FP1		6.98
35Z5		.46	5687	1.98	3FP1		6.98
80L6		.60	5687	1.59	3FP7A		6.91
			5692	6.48	10P1		6.91
71A		.74	5693	6.48	10P1		6.91
HY69		6.49	CK5694	1.70			
QK315		69.00	CK5695	1.70	5CP1A		14.49
QK202		95.00	CK5702	1.70	5CP1		14.49
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2	3.48	3.90	6.15	6.75	11.60	23.15	2.70	18.25	35.50
3	3.48	4.30	6.35	6.75	11.60	23.15	2.70	18.25	35.50
4	4.25	5.45	13.05	16.30	28.45	44.45	3.40	21.70	42.45
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10	7.70	15.40	23.10	28.60	47.45	89.00	4.50	29.50	57.50
12	9.20	18.10	25.40	34.20	60.85	114.00	6.80	40.15	94.20
20	15.00	28.50	42.80	56.85	99.70	184.95	9.15	59.50	117.00
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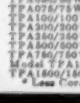

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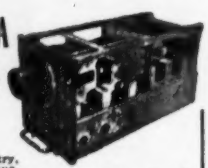

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2J33 ..... 14.50	4J42 ..... 25.00	FG104 ..... 29.50	434A 3.00	829B 8.50	5634 ..... 7.50	9006 ..... .25
2J34 ..... 14.50	4J50 ..... 99.50	FG105 ..... 11.00	446A ..... .50	830B ..... .75	5636 ..... 4.00	
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2J39 ..... 10.00	4J57 ..... 100.00	F128A 13.00	450TL 35.00	833A 27.50	5651 ..... 1.40	
2J40 ..... 14.50	4J58 ..... 100.00	FG154 ..... 15.00	WL456 ..... 59.50	834 ..... 5.00	5654 ..... 1.50	

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25 WATT

Ohm	Shaft	Price	Length
1.5		65¢	
2	7/16"	79¢	
4	7/16"	79¢	
10	7/16"	79¢	
15	7/16"	79¢	
20	7/16"	79¢	
25	7/16"	79¢	
50	7/16"	79¢	
75	7/16"	79¢	
100	7/16"	79¢	
150	7/16"	79¢	
200	7/16"	79¢	
250	7/16"	79¢	
500	7/16"	79¢	
750	7/16"	79¢	
1000	7/16"	79¢	
1500	7/16"	79¢	
2000	7/16"	79¢	
2500	7/16"	79¢	
3000	7/16"	79¢	
4000	7/16"	79¢	
5000	7/16"	79¢	
6000	7/16"	79¢	
7500	7/16"	79¢	
8000	7/16"	79¢	
10000	7/16"	79¢	

25 WATT

Ohm	Shaft	Price	Length
1000	1 1/16"	89¢	
1000	7/16"	89¢	
2000	7/16"	89¢	
5000	7/16"	89¢	
10000	7/16"	89¢	

50 WATT

Ohm	Shaft	Price	Length
1000	1 3/16"	1.79	
.25		65¢	1.79
1	7/16"	1.09	
5	7/16"	1.09	
10	7/16"	1.09	
15	7/16"	1.09	
20	7/16"	1.09	
25	7/16"	1.09	
50	7/16"	1.09	
75	7/16"	1.09	
100	7/16"	1.09	
150	7/16"	1.09	
200	7/16"	1.09	
250	7/16"	1.09	
500	7/16"	1.09	
750	7/16"	1.09	
1000	7/16"	1.09	
1500	7/16"	1.09	
2000	7/16"	1.09	
2500	7/16"	1.09	
3000	7/16"	1.09	
4000	7/16"	1.09	
5000	7/16"	1.09	
6000	7/16"	1.09	
7500	7/16"	1.09	
8000	7/16"	1.09	
10000	7/16"	1.09	

75 WATT

Ohm	Shaft	Price	Length
500	1 3/16"	1.79	
25		65¢	1.79
1	7/16"	1.09	
5	7/16"	1.09	
10	7/16"	1.09	
15	7/16"	1.09	
20	7/16"	1.09	
25	7/16"	1.09	
50	7/16"	1.09	
75	7/16"	1.09	
100	7/16"	1.09	
150	7/16"	1.09	
200	7/16"	1.09	
250	7/16"	1.09	
500	7/16"	1.09	
750	7/16"	1.09	
1000	7/16"	1.09	
1500	7/16"	1.09	
2000	7/16"	1.09	
2500	7/16"	1.09	
3000	7/16"	1.09	
4000	7/16"	1.09	
5000	7/16"	1.09	
6000	7/16"	1.09	
7500	7/16"	1.09	
8000	7/16"	1.09	
10000	7/16"	1.09	

100 WATT

Ohm	Shaft	Price	Length
10	7/16"	1.09	
15	7/16"	1.09	
20	7/16"	1.09	
25	7/16"	1.09	
37	7/16"	1.09	
50	7/16"	1.09	
100	7/16"	1.09	
150	7/16"	1.09	
200	7/16"	1.09	
250	7/16"	1.09	
500	7/16"	1.09	
750	7/16"	1.09	
1000	7/16"	1.09	
1500	7/16"	1.09	
2000	7/16"	1.09	
2500	7/16"	1.09	
3000	7/16"	1.09	
4000	7/16"	1.09	
5000	7/16"	1.09	
6000	7/16"	1.09	
7500	7/16"	1.09	
8000	7/16"	1.09	
10000	7/16"	1.09	

150 WATT

Ohm	Shaft	Price	Length
25	7/16"	2.85	
100	7/16"	2.85	
150	7/16"	2.85	
200	7/16"	2.85	
250	7/16"	2.85	
500	7/16"	2.85	
750	7/16"	2.85	
1000	7/16"	2.85	
1500	7/16"	2.85	
2000	7/16"	2.85	
2500	7/16"	2.85	
3000	7/16"	2.85	
4000	7/16"	2.85	
5000	7/16"	2.85	
6000	7/16"	2.85	
7500	7/16"	2.85	
8000	7/16"	2.85	
10000	7/16"	2.85	

PRECISION WIREWOUND RESISTORS

¼ WATT - 30¢

OHMS	OHMS	OHMS	OHMS	OHMS	OHMS
.12	10.04	33.62	191.8	301.8	2,193
.627	11.26	34.06	221.8	344.6	2,800
2.5	13.14	38.68	227.5	348.5	3,500
6.66	13.32	56.17	228.4	703.1	10,000
10.48	13.82	62.54	229.4	723.1	50,148
	13.15	79.01			

½ WATT - 35¢

.25	25	250	4,300	14,825	35,000
.334	46	279	4,451	15,000	37,000
.444	50	298.3	4,500	16,750	45,000
.667	55.1	400	5,000	16,760	46,000
.857	66.6	500	6,000	17,000	50,000
10	77	600	6,250	20,000	60,000
5	90	1,000	7,000	30,000	68,000
1.01	97.8	2,250	7,300	32,780	100,000
2.04	125	2,500	7,500	33,000	125,000
2.04	180	3,000	8,000	33,000	150,000
15.1	210	3,427	8,000	33,300	200,000
15.1	235	4,000	12,000	35,385	500,000
			15,000		

1 WATT - 45¢

2	5.21	425	4,000	15,000	55,000
225	10	1,200	5,000	20,000	60,000
661	38	2,000	6,000	30,000	80,000
1.01	50	2,200	8,250	40,000	84,000
2.01	250	2,500	9,000	50,000	85,000
3.03	270	3,000	10,000		
3.39	420	3,300	12,000		

1 WATT - 60¢

100,000	110,000	220,000	270,000	320,000	500,000
105,000	112,000	240,000	290,000	340,000	645,000
120,000	150,000	250,000	297,000	350,000	680,000
170,000	175,000	260,000	300,000	400,000	700,000
				522,000	

1 MEGOHM 1 WATT 1%—90¢; 5%—60¢

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	Tol.	1 to 99	100 of a value
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		.10 ea.	6.00
1 WATT	10% 5%	.08 ea.	5.00
		.16 ea.	11.00
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		.20 ea.	18.00

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• JLU Locking Bushing • Shaft for Knob

Your Choice—95¢ ea.

OHMS	OHMS	OHMS	OHMS	OHMS
	1K	5K	50K	500K
100	1500	6K	75K	1 MEG
250	2K	10K	100K	2 MEG
500	2500	15K	150K	5 MEG
	3K	25K	250K	5 MEG

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BARGAIN: SO 239 / PL 259 } **35¢ ea.** Brand New

83-1AC	$.42	83-22R	5.48	UG		UG	
-1AP	.30	-22SP	.80	27C/U	$2.80	261B/U	5.95
-1BC	.30	-227T	1.35	28A/U	2.80	262/U	.80
-1P	1.10	-256	.12	29B/U	1.45	262A/U	.85
-1H	.12	-261	.12	30D/U	1.50	262B/U	.95
-1HP	.12	M-358	1.30	57B/U	1.15	273/U	1.45
-1J	.70	M-359	.30	58/U	.75	274/U	2.10
-1N	.35	M-359A	.65	58A/U	.85	274A/U	2.40
-1NTV	.65	PL-258	.75	175/U	.80	290/U	.65
-1SF	.55	PL-259	.35	176/U	.12	290A/U	.90
-1SPN	.35	PL-259A	.35	212C/U	2.90	291/U	.90
-1T	1.10	PL-2271	1.10	260/U	.70	291A/U	.95
-22AP	1.40	SO-239	.35	260A/U	.70	291B/U	1.00
-22P	2.10	UG-		268B/U	.80	625/U	.90
-22J	1.40	21B/U	1.00	261/U	.80	625A/U	1.05
		27B/U	2.35	261A/U	.85	1698/U	2.00

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PARTIAL LISTING OF OUTSTANDING SURPLUS COMMUNICATIONS EQPT.

WE 248-A RADIOTELEPHONE EQP'T. 250/350 Watts, 2-20 MC. 30 Channels Transmit and Receive all crystal-controlled, monitors 3 separate channels simultaneously, uses standard modern type tubes. COMPLETE, NEW (Not Gov't. Surplus). Operates from 110 Volts, 50/60 Cycles AC. IDEAL FOR SHIP RADIOTELEPHONE, OR FIXED-RADIO INSTALLATION. WRITE FOR DESCRIPTIVE LITERATURE AND PRICE.

GE 10 KW RF POWER AMPLIFIERS. 88-108 MC. Class "C", with separate Rectifier Power Supply. Operation from 220 V., 3-phase, 50/60 Cycles AC. Easily modified for other frequencies. NEW. Not Gov't. Surplus. WRITE FOR DESCRIPTIVE LITERATURE AND PRICE.

MODEL LSR 420F: RADIO BEACON OR SHIP RADIO TRANSMITTER. Freq. Range 375-510 KC. Power Output 100 Watts CW, 150 Watts MCW. Operates from 115 V. AC, 60 C. New Eqpt.

LSR-520-C RADIO BEACON POWER AMPLIFIER. Class B Linear Amplifier used with above LSR-420 to increase power output to 600 Watts CW or 800 Watts MCW. Operates from 115 Volts 60 C. AC.

BC-797 VHF 10-126 MC. 50W. AM Output for 110 V. 50/60 C. AC.

BC-460 Collins Autotune Transmitter, 250 W. A1, 200 W. A3 or A5, 10-Channels 2-16 mc.

BC-447. 500 W. A1, 4-13.4 mc. 2-channels.

SCR-510/610. FM Trans-Receiver. 30 to 28 and 28 to 37 mc respectively. With PE-117 or 120 Vibrator Power Supply and other accessories.

SCR-619. FM Trans-Receiver 27 to 38.9 mc. complete with all accessories. NEW units.

SCR-522. VHF, 4-Channel, 100-156 MC Trans-Recvg. Eqt. for Plane or Ground Communications.

SCR-511. Walky-Talky, 3-6 MC, Crystal Controlled Trans-Recvg. with Plug-in Units for Freq. Changing.

BC-611 SCR-536. HANDY and WALKIE-TALKIES.

SCR-300 (BC-1000) WALKIE-TALKIES, 40-48 MC 2 channel FM Trans-Receivers.

TCS X-mttr-Receiver for Ship or Shore.

TCS Accessories available; Remote Controls, Antenna Loading Coils, Etc.

TBK HF 500W 2-20 Mc Transmitter with MG. Starter and Spares.

TAJ 500 W. Output, 175-550 Kc. with M.G. for AC or DC operation.

TAQ. Same as TAJ above but 1,000/1,500 W. output with MG.

TBL 350 W. Output, A1, A3, IF. & H.F. for AC or DC operation.

PE-75U Gas Engine Generators NEW, w/Spares.

T-21/GR-3-C Sound Ranging Microphones for locating Artillery Fire.

RC-263 TRANSMITTING EQP'T. 1.5-10.0 mc. 4-channel crystal or VFO control. Operates from 100 to 260 V. AC, 25-60 cycles built-in power supply 75 Watts CW, 50 W. phone conservative output rating. NEW. Complete with Remote Control and case of spares. LARGE QUANTITY IN STOCK!

SCR-543 RADIOTELEPHONE EQP'T. 45 W, Radiotelephone (Trans-Receiver Eqpt.), 6-channel 1.5 to 4.3 mc, crystal controlled. NEW and used excellent units. LARGE QUANTITY IN STOCK!

LINK-1498, VHF Trans-Recvg Eqpt, 70-100 MC, 50 Watts output FM. Available in 14 VDC & 110 V AC operation.

150-AY Mackay IF Ship X'mttrs.

8707 RMCA Ship Radio Compass.

LRN-1A Loran Equipment.

TE-54 & 55 Cable Vulcanizing Equipment.

SB-14GY Console Switchboard.

SB-23/GTA Power Supply for above.

BC-224 Receivers.

HEADQUARTERS FOR TCS EQUIPMENT AND SPARE PARTS; WALKIE-TALKIES (SCR-300 OR BC-1000) AND SPARE PARTS, HANDY TALKIES (SCR-536 OR BC-611) AND SPARE PARTS, SCR-543 (BC-669 AND ACCESSORIES) IN NEW OR LIKE NEW CONDITION. WE HAVE LARGE QUANTITIES OF THESE EQUIPMENTS. ALSO DM-35 DYNAMOTORS AND PE-104 (FOR SCR-284) VIBRATOR POWER SUPPLIES, GN-58 HAND GENERATORS, AND PE-237 POWER SUPPLIES FO RSCR-694 AND GRC-9 EQUIPMENTS. WRITE FOR PRICES & DESCRIPTIVE LITERATURE.

SELECTIVE RINGER for MOBILE or SHIP-TO-SHORE RADIOTELEPHONES Permits Phone Operator to call your Radiotelephone exclusively, when operator has a call for you, by ringing a bell or lighting a light. Designed & Mfd. by Western Electric, MODEL 107A, modern, compact and efficient. Can be attached to any receiver, complete Instruction Book supplied. Dim.: 15⅞" long, 8⅛" high, 5⅛" wide. Shpg. Wt. 25 lbs. **NEW UNITS.** Reg. value $345.00 each. **OUR LOW PRICE—EACH $85.00.**

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SPECIAL PURPOSE TUBES

OA2	$ .75	2K54	7.50	EL-C6A	6.00	RK-65	7.00	EL-302.5	5.00	800	1.50	1616	.50
OA3	.90	2K55	5.00	EL-C6J	6.50	FG-67	9.00	CE-303	2.25	801A	.50	1619	.30
OA5	4.00	2P21 (image orthicon)	50.00	EL-C6L	3.75	RK-69	2.00	WE-304B	7.50	802	2.25	1620	3.25
OB2	.65	2V3G	1.35	EL-6C	8.00	RK-72	.50	304TH	8.50	GL-803	2.00	1622	1.50
OB3	.75	2X2	.35	6AC7W	.75	RK-73	.50	304TL	15.00	803	1.40	1623	2.35
OC3	.70	2X2A	.90	6AJ5	1.15	HY-75	3.00	WE-305A	3.00	804	9.00	1624	.95
OD3	.70	3A4	.50	6AJ6	2.00	RK-75	.85	CE-306	7.50	805	4.50	1625	.30
EL-C1B	2.00	3A5	.50	WE-6AK5	1.35	VR-75	.90	307A	.85	806	5.00	1630	.40
EL-1C	1.50	3AP1	3.00	6AK5W	1.35	75TL	5.50	CE-309	2.75	807	1.20	1631	1.40
XFG1	2.00	3B21	5.00	6AL5W	.65	VR-78	.50	WE-310A	3.50	807W	3.85	1635	1.50
1AF4	2.50	3B22	1.50	6AN5	2.75	FG-81A	5.00	WE-311A	5.00	808	1.00	1636	1.00
1AG5	2.00	3B22	1.50	6AR6	1.25	VR-90	.75	WE-313C	2.85	809	2.50	1641	1.35
1B22	1.35	2B23	3.50	6AS6	1.25	CV-92	3.50	316A	.50	810	10.00	1642	.50
1B23	3.00	3B24	1.00	6AS6W	1.50	FG-95	17.50	WE-323A	7.50	811	2.75	1649	1.00
1B24	5.00	2B24W	5.00	6AS7G	2.35	VT-98BR	12.50	323B	4.50	811A	3.50	1654	3.50
1B27	10.00	3B25	3.00	6BM6	20.00	HF-100	7.50	WE-328A	3.50	812	2.25	1656	6.50
1B32	1.00	2B26	2.85	6C21	17.50	100R	5.00	WE-331A	7.50	RCA-813	12.50	1661	6.00
1B35	4.50	3B27	3.00	6G4	2.00	100TH	6.50	WE-337A	10.00	814	1.75	1846	50.00
1B36	3.75	3B28	5.50	6J4	3.00	WE-102D	2.50	WE-339A	10.00	815	1.50	1851	1.75
1B38	25.00	3BP1	2.50	6J6W	1.25	FG-105	12.00	WE-347A	3.00	816	1.25	1904	9.00
1B40	2.35	EL-3C	5.00	6L6WGB	3.35	VR-105	.70	WE-349A	7.50	822	10.00	1960	.50
1B42	4.50	EL-3CJ	8.50	6SC7GTY	2.00	VU-111S	1.00	WE-350A	3.00	826	.75	1984	10.00
1B47	7.50	3C23	3.50	6SN7WGT	1.50	HY-114B	.75	350B	2.50	828	7.50	2000T	175.00
1B59	10.00	3C24	2.50	6SU7GTY	2.00	WE-121A	3.50	WE-352A	15.00	829	6.00	2050	.95
1C21	2.00	3C31	2.00	7BP7	5.00	WE-122A	1.50	F-353A	2.00	829B	8.50	2051	.65
1P23	2.00	3C33	9.50	7CP1	12.50	F-123A	3.50	WE-353A	3.50	830B	.75	2172	10.00
1P24	.50	3C37	10.00	7EP4	10.00	WE-123A	5.00	WE-354A	14.00	832	3.75	2183	5.00
1P28	8.75	3C45	6.00	9GP7	5.00	WE-124A	3.75	WE-355A	15.00	832A	5.00	ZB-3900	75.00
1P29	1.50	3D21A	5.00	9LP7	3.50	VT-127A	2.50	WE-356B	7.50	833A	30.00	R-4100	5.75
1P30	1.50	3D22	9.75	9MP7	7.50	F-128A	15.00	WE-368A	2.00	834	5.75	R-4330	8.50
1P32	1.00	3DP1	3.75	10Y	.25	HF-130	.90	WE-368AS	2.50	835	5.00	5528	3.75
1P34	1.75	3DP1A	7.50	CE-11V	2.25	VR-150	.70	371A	1.00	836	1.50	5550	25.00
1P36	2.50	3E29	8.50	12A6	.50	FG-154	15.00	371B	1.50	837	.90	5551	35.00
1Z2	2.00	3EP1	2.00	12DP7A	25.00	HK-154	5.00	WE-388A	1.50	GL-838	2.00	5553	100.00
CE-2C	1.50	3FP7	2.00	12GP7	17.50	FG-166	15.00	WE-393A	5.00	838	.75	5556	6.75
VG-2	7.50	3FP7A	3.50	12J5WGT	1.50	FG-172	15.00	394A	1.85	842	2.25	5557	2.75
2A4G	1.15	3GP1	2.00	12K8Y	.50	QK-181	20.00	WE-394A	3.00	843	.35	5560	17.50
2AP1	4.00	3HP7	3.00	12L8GT	.75	FG-190	7.50	WE-396A	3.00	845	5.00	5610	1.00
2AP1A	5.00	3J21	50.00	LM-15	50.00	HF-200	10.00	WE-404A	10.00	845W	8.50	5632	8.50
2AS15	3.75	3J31	35.00	NE-16	.30	CE-201	2.75	410R	100.00	849	18.50	5637	5.00
2B21	.90	3K27	150.00	FG-17	2.75	CE-203	5.00	WE-417A	10.00	851	10.00	5644	7.50
2B26	1.25	3KP1	6.00	RK-19	.85	203A	2.50	WL-417A	2.85	852	5.00	5645	6.50
2C21	.50	3RP1	7.25	RK-20A	7.50	203Z	5.00	WE-418A	12.50	860	3.00	5650	85.00
2C22	.35	3X2500A3	125.00	TZ-20	1.75	204A	25.00	WE-421A	7.50	861	15.00	5651	1.35
2C24	.75	4-400A	40.00	CE-21C	2.00	WE-205B	.75	GL-434A	10.00	865	.35	5654	1.35
2C25	.35	4AP10	3.75	RK-21	.85	207	50.00	446A	.50	866A	1.10	5656	6.50
2C26A	.50	4B22	6.50	RK-22	3.50	211	.50	446B	1.85	866-JR	1.25	5670	1.50
2C33	.75	4B23	6.50	CE-23C	1.40	WE-211C	10.00	451	5.00	868	2.00	5687	2.50
2C34	.35	4B24	5.00	PJ-23	2.00	WE-211D	8.00	WL-460	8.50	869B	30.00	5691	4.50
2C38	10.00	4B25	8.00	RK-23	2.50	WE-212E	25.00	464A	2.25	GL-872A	2.50	5696	1.00
2C39	5.00	4B26	3.00	HK-24	2.85	217A	1.50	WL-468	12.50	CE-872A	1.50	5703	1.00
2C39A	10.00	4B27	2.75	HK-24G	2.00	217C	3.00	RH-507	20.00	872A	1.35	5720	15.00
2C40	7.50	4B28	3.00	CE-25A/B	2.00	WL-218	20.00	CK-510AX	.50	874	.50	5725	1.50
2C42	10.00	4B30	.75	RK-25	2.25	CE-220	.50	527	15.00	876	.75	5726	.65
2C43	7.50	4B32	10.00	25E6WG	4.00	CE-221	8.00	WL-530	25.00	878	.50	5727	1.40
2C44	.35	4C22	7.50	25T	2.85	221A	2.00	WL-531	7.50	879	.35	5728	9.00
2C46	6.00	4C25	3.00	25TG	2.50	CE-222	1.50	WL-532A	1.00	884	1.00	5740	44.00
WE-2C51	3.00	4C27	3.50	CE-28D	2.50	CE-224	5.00	GL-546	2.00	885	1.00	5763	1.00
2C53	10.00	4C35	15.00	RK-28	2.50	CE-225	3.00	559	.50	902P1	3.00	5801	2.50
2D21	.65	4E27	8.00	28D7	.75	CE-226	3.00	GL-575A	10.00	905	8.00	5819	25.00
2D21W	1.40	4J34	35.00	28D7W	1.50	WE-231D	2.00	WL-579B	10.00	913	20.00	5820	400.00
2E22	2.00	4J52	35.00	CE-29	1.25	RX-233A	.75	631-P1	5.75	917	2.25	5827	2.50
2E24	1.95	4X100A	18.50	CE30C	1.25	CE-235A	5.00	WL-632A	17.50	918	1.85	5829	1.50
2E25	1.85	EL-C5B	1.00	Twin 30	7.50	WE-242A	5.00	WL-655,658	100.00	919	2.00	5848	10.00
2E26	3.25	EL-5BHD	6.50	HY-30Z	2.65	WE-249C	8.00	WL-670A	8.00	920	2.00	5847	10.00
2E29	1.00	EL-5B2.5	6.50	CE-31V	2.00	WE-249B	2.50	WL-681,686	25.00	921	1.00	5933	4.00
2E36	1.25	5AP1	3.00	FG-32	6.00	WE-249C	2.50	WE-701A	2.00	922	1.20	5933	4.00
2E41	2.00	5B21	2.00	FG-33	15.00	250R	4.75	702A	.50	923	1.40	5948	250.00
2J21A	2.75	5BP1	2.50	RK-33	.50	250TH	18.50	702B	1.00	924	1.35	5963	1.25
2J26	4.75	5BP1A	7.50	VX-33A	2.50	250TL	15.00	703A	1.50	925	2.00	5981/5650	85.00
2J27	4.75	5BP2A	5.00	RK-34	.35	WE-251A	47.50	WE-704A	.85	926	2.50	5998	7.50
2J29	15.00	5BP4	2.00	35T	4.50	WE-252A	9.50	705A	.75	927	1.00	6031	4.75
2J30	15.00	5C21	7.50	35TG	3.00	WE-253A	3.50	707A	3.00	928	2.50	6097	.65
2J31	14.00	5C22	25.00	RK-38	6.50	WE-254A	4.75	707B	4.50	929	1.25	6187	1.50
2J32	14.00	5C30	1.00	RK-39	1.50	HK-257B	8.50	WE-708A	.75	930	1.25	6188	2.00
2J33	14.00	5CP1	2.00	T-40	2.35	WE-257A	3.50	WE-709A	1.00	931A	3.00	R-6210	15.00
2J34	14.00	5CP1A	8.50	TZ-40	3.50	FG-258A	100.00	713A	.35	SN-948	7.50	UX-6653	.75
2J36	15.00	5CP7	8.50	VX-41	2.50	WE-261A	10.00	715A	2.00	954	.30	8001	8.50
2J37	5.00	5D21	5.50	CE-42C	1.50	WE-262B	7.00	715B	4.00	955	.35	8002R	15.00
2J38	10.00	5D23	7.00	RK-44	1.00	WE-264C	3.00	715C	12.00	956	.35	8005	4.75
2J39	10.00	5FP7	1.35	QK-47	50.00	WE-267B	10.00	WE717A	1.00	957	.35	8008	6.00
2J40	14.00	5FP14	5.00	RK-47	1.75	WE-268A	7.50	717A	.35	958A	.35	8011	.75
2J50	35.00	5GP1	5.00	CE-48	1.75	FG-271	25.00	WE-719A	9.50	959	1.50	8012	1.00
2J51	100.00	5J29	7.50	RK-49	2.85	WE-272A	5.00	721A	.75	972A	3.50	8012A	2.50
2J52	50.00	5J30	5.00	HY-51B	.75	WE-274A	3.00	721B	7.25	991	.30	8013	2.75
2J53	25.00	5J32	15.00	FP-54	44.00	WE-274B	1.00	722A	3.50	1000T	100.00	8013A	3.50
2J54	50.00	5JP1	12.50	HK-54	2.00	274B	.50	723A/B	9.00	CK-1005	.25	8016	2.50
2J55	50.00	5JP2	7.00	T-55	3.50	WE-275A	5.00	WE-724A	.85	CK-1006	2.00	8020	1.50
2J56	75.00	5JP4	7.00	RK-57	4.50	WF-276A	7.50	WE-724B	.85	CK-1007	.65	8021	.75
2J61	15.00	5JP5A	7.00	RK-58	.90	276A	2.50	WE-725A	3.00	CK-1009	3.50	8022	.75
2J62	4.75	5JP11	10.00	QK-59	25.00	WE-282A	7.50	WE-726A	5.00	CK-1096	3.00	8025	1.50
2J62A	50.00	5LP1	7.50	QK-60	25.00	WE-283A	4.00	WE-726B	25.00	R-1100	5.00	8025A	2.00
2JB51	.35	5LP1A	20.00	RK-60	1.35	WE-285A	5.00	WE-726C	20.00	R-1130B	10.00	8026	3.50
2K25	12.50	5NP1	2.50	HY-61	1.25	WE-286A	6.00	WE-730A	7.50	1500T	115.00	PD-8365	50.00
2K28	35.00	5R4GY	.90	QK-61	25.00	287A	3.50	WE-732A	2.00	1603	3.00	9001	.85
2K30	100.00	5R4WGY	2.25	RK-61	2.75	WE-295A	5.00	WL-735	2.00	1608	3.75	9002	.65
2K33A	65.00	5X3	3.00	QK-62	25.00	WE-296A	25.00	WL-741	1.40	1611	1.50	9003	.90
2K41	75.00	5X3P1	75.00	RK-62	1.75	HF-300	17.50	750TL	40.00	1612	1.25	9004	.35
2K45	40.00	5Z2P7	50.00	RK-63	18.50	WE-300B	6.50	WL-759	12.50	1613	1.00	9005	1.40
2K47	125.00	5Z4P11	100.00	HY-65	1.85	CE-302	3.50	WL786	15.00	1614	1.50	9006	.25

The prices quoted above are FOB shipping point

western engineers

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

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Type	Price
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CEP-220	.84
CK-1R4AX	.99
CK-5Z4AX	.99
CRP-72	.79
DG-12N9	3.95
EF-50	.35
E-1148	3.50
EC1	.39
EM80A	.39
F1T1A	3.95
F12A	4.95
F128A	19.50
FG-105	17.50
FG-154	36.95
HF-100	6.95
HF-150	16.95
HF-200	10.95
HF-300	19.95
HK-24	3.99
HK-54	3.49
HY-114B	.69
HY-615	.29
KU-610	4.99
QX-59	39.50
QK-61	63.60
QK-62	69.00
QK-185	110.00
RK-34	.39
RK-35	5.45
RK-50	5.45
RK-60	3.40
RK-65	9.95
RX-21A	5.99
UH-50	1.99
105/VT-25A	.89
VR-78	.80
VR-88	.80
VR-105	.80
VR-150	.80
VT-52	.89
205/VT-67	.89
VT-127A	2.99
VT-158	15.00
VU-111	.89
OA2	.84
OA3	1.10
OB2	.84
1B22	3.40
1B24	5.99
1B26	3.19
721	3.40
1B35/832A	.99
1N21	.99
1N22	.48
1N23	1.29
1N27	1.00
1P21	9.00
1P28	2.99
2AP1	5.95
2B22	5.95
2BP1	7.95
2C22	3.50
2D21	3.99
2C26	.22
2C26A	.49
2C34	4.95
2C51 with WX233	11.60
2C39A	8.40
2C39A based	12.40
2C40	6.99
2C43	10.40
2C43 based	14.40
2C45	4.95
2C50	11.75
2D21	.75
2D21W	1.45
2E22	5.95
2E24	3.25
2E26	1.39
2G-72	1.59
2J21	3.79
2J-32	3.59
2J-36	4.99
2J-37	6.99
2J-51	14.99
2J-52	16.99
2J-38	16.50
2J-39	17.95
2J-40	29.50
2J-42	69.00
2J-47	34.00
2J-48	15.99
2J-62	8.99
2K-22	18.99
2K-23	19.95
2K-25	14.99
2K-28	28.99
2K-33A	79.50
2K-39	144.00
2K-41	94.00
2K45	49.50
2K48	55.00
2KP1	55.00
2K50	19.50
2K55	29.95
2s2/879	.59
3V1	1.29
3A5	1.59
3AP1	5.99
3BP1	3.29
3B22	5.95
3B23	3.99
3B24	2.49
3B24W	4.99
3B28	3.25
3B27	11.60
3C21	3.49
3C22	.94
3C22	64.95
3C23	4.85
3C24	2.65
3C28	4.99
3C30	1.47
3C31	15.95
3C33	7.50
3D22	4.85
3E29	9.99
3E29	9.99
3FP1	3.99
3GP1	2.85
3HP1	3.99
3J21	79.95
4A-11	.49
4AP-10	1.99
4B22	6.49
4B25/EL6C	6.99
4B26/CE22B	2.99
4-125A	18.99
4B35	2.99
4C27	5.95
4C28	13.50
4C35	14.99
4D22	5.95
4D32	19.95
4E27	8.95
4J22	34.50
4J26	34.50
4J32	44.50
4J36	34.50
4J50	34.50
4J96	59.50
4J27	59.50
4J28	59.50
4J29	59.50
4J38	68.50
4J33	49.50
4J34	49.50
4J36	49.50
4AP1	4.99
4BP1	2.99
4BP1A	3.95
5BP4	2.99
5CP1	2.99
5CP1A	10.50
5CP11	15.50
5CP11A	15.50
5CJ	5.49
5C22	28.99
5D21	7.99
5BP1A	5.99
5FP7	1.99
5HP4	1.99
5HP1	1.99
5JP1	14.50
5JP5	5.45
5KP7	16.50
5J99	9.00
5J30	16.65
5J33	5.90
5LP1	8.25
5MP1	5.99
5R4GY	1.60
5R4WGY	2.22
6-6	1.49
6C21	15.00
6F4WA	5.35
7C22	49.50
7C25	89.50
7BP3	6.99
7BP7	6.99
9LP7	5.50
10Y	.31
12X3	1.66
15E	1.89
15H	.39
15J	1.89
24A	1.99
25TG	4.44
45A	2.99
89Y	.10
100TH	6.99
100TL	6.99
203	4.99
204A	19.49
205B	.95
207	49.50
211	3.49
211A	3.49
211B	2.49
211C	2.49
211D	2.99
211E	2.99
211F	2.99
211G	2.99
250TH	19.50
250TL	21.50
723	3.40
1B3	3.50
1B4	4.49
259A	6.99
261C	3.44
272A	32.00
274A	5.49
274B2	1.95
282A/B	4.50
285A	7.46
287A	5.61
304TH	6.50
304TL	10.99
307A/WK75	1.99
310A	4.64
326A	.46
327A	3.49
328A	4.99
336A	4.99
347A	3.99
350B	1.00
371B	1.00
388A	1.49
391A	4.64
391AA	4.99
417A	6.99
434A	3.99
446A	1.49
446B	2.29
WL-446A	5.99
WL-446A	4.79
GL-471A	2.18
527	22.50
WL-530	10.95
WL-535	4.59
WL-532	.99
GL-559	3.99
700A/B/E/D	5.99
701A	4.99
701A	1.90
703A	2.99
704A	1.99
705C	18.95
717A	3.99
720B	10.95
720C	18.95
723A/B	3.99
724A/B	1.29
726A	5.95
726A	9.50
726B	26.50
726C	26.50
730A	9.99
800	.89
801A	.89
802	2.89
803	2.99
804	10.50
805	4.25
806	10.50
807	1.99
808	2.45
809	3.49
810	9.96
811	3.39
812	2.99
813	10.50
814	2.99
828	9.75
829B	15.45
836B	1.99
832A	8.49
833A	37.49
836	2.95
837	1.99
838	1.99
841	.26
843	.49
845	7.49
851	322.00
853	12.48
860	1.99
861	34.95
864	.69
865	1.12
866A	1.19
869B	15.99
872A	1.28
874	.96
876	1.99
878	1.99
885	1.49
9-3	.69
902A	3.99
918	1.29
927	1.65
931A	2.99
954	.26
955	.49
956	.59
957	.59
958	.59
991	1.99
992	.33
1000T	6K5GT	.79	7Y4	.69
CK1005	.49	6A5TG	2.99	7Z4	.69
CK1006	.49	6AK6	.79	12A6	.49
1600	2.99	6AL5G	.59	12AT6	.49
1613	.99	6BA7	.89	12AU7	.99
1614	1.99	6BE6	.99	12AT7	.94
1616	.99	6BF6	.99	12AV7	.94
1622	1.49	6BG6G	1.99	12AX4	.89
1623	1.49	6BH6	.79	12AX7	.89
1625	.29	6BE6	.69	12AY7	1.21
1626	.21	6BK7A	1.21	12BA6	.64
1629	.22	6BL7	1.10	12BA7	.64
1630	.69	6BM6	.59	12SC7	.89
1631	.49	6BN6	1.26	12SG7	.89
1632	.49	6BQ6	1.19	12SR7	.89
1639	.89	6BQ7A	1.59	12SF7	.82
1641	2.49	6CD6	1.72	12SK7	.89
1642	.29	6CB6	.69	12HG	.89
1644	.69	6C4	.49	12SH7	.89
1851	2.99	6C5	.49	12K8	.89
1852	1.35	6C5G	.49	12SN7	.89
1908	.99	6D4	2.75	12SL7	.89
2050W	1.19	6E5	.79	12Z3	.49
2051	.81	6F6	.99	14A7	.89
1A3	.89	6F6G	.99	14B6	.89
1B3	.89	6F8G	1.29	12B8	.89
1GEGT	.69	6G6	1.29	14E7	.89
1LC5	.99	6J6	.72	14R7	.89
1LD5	.94	6J7	.94	14W7	.99
1L4	.84	6K4	2.69	14Y7	.89
1L5	.89	6K5	.79	25L6	.64
1N5	.89	6K6	.79	26Z6	.89
1R5	.89	6K7	.79	25Z6	1.79
1S4	.89	6K8	1.19	25Z6G	.89
1S5	.89	6L6M	1.24	35Z3	.81
1T4	.89	6L6G	.99	35Z5	.89
1U4	.69	6L7	.99	35Y4	.69
1U5	.69	6N7	1.10	50A5	.89
1X2A	.69	6N7GT	.89	50B5	.89
1Y2	.69	6S4	.89	50C5	.89
2A3	.99	6SC7	.89	50L6	.89
2A5	.99	6SF5	.74	75	.69
2B7	.99	6SG7	.89	78	.69
2C5	.99	6SH7	.64	80	.69
2C26A	.69	6SK7	.64	83V	.99
2D21	.84	6SL7	.89	85A1	1.39
2E24	.99	6SN7	.89	85A2	1.39
2E26	.89	6SQ7	.89	85A3	1.39
2E30	.99	6V4	.89	85B1	1.39
2E32	.99	6V6	.89	85B2	1.39
2E35	.99	6V6GT	.89	85B3	1.39
2E36	.99	6W4	.89	85C1	1.39
2E41	.99	6W6	.84	85C2	1.39
2E42	.99	6X4	.49	85C3	1.39
2E44	.99	6X5	.89	90C1	1.39
2E46	.99	6Y6	1.49	90C2	1.39
2E50	.99	6Z4	.89	90C3	1.39
2E51	.99	7A4	.89	95	.89
2E54	.99	7A5	.89	99	.89
2E56	.99	7A6	.89	100TH	1.30
2E66	.99	7A7	.89	100TL	1.30
2E74	.99	7B5	.89	211	1.30
2E75	.99	7B6	.89	250TH	19.50
2E76	.99	7C4	.89	250TL	19.50
2E78	.99	7C5	.89	807	.89
2E79	.99	7C6	.89	807W	.89
2E80	.99	7C7	.89	808	4.90
2E81	.99	7E5	.89	809	2.50
2E82	.99	7E6	.89	811A	3.94
2E83	.99	7F7	.89	812	2.50
2E84	.99	7G7	.89	813	2.50
2E85	.99	7H7	.89	814	2.50
2E86	.99	7N7	.89	829	1.79
2E87	.99	7S7	.89	832	1.79
2E88	.99	7V7	.89	832A	1.79
2E89	.99	7W7	.89	866A	1.79
2E90	.99	7X7	.89	872A	1.79
2E91	.99	7Y4	.69	931A	1.79
2E92	.99	7Z4	.69	1616	1.79
2E93	.99	12A6	.49	1619	1.79
2E94	.99	12AT6	.49	1625	1.79
2E95	.99	12AU7	.99	1626	1.79
2E96	.99	12AT7	.94	1629	1.79
2E97	.99	12AV7	.94	1630	1.79
2E98	.99	12AX4	.89	1631	1.79
2E99	.99	12AX7	.89	1632	1.79
2E100	.99	12AY7	1.21	1639	1.79
2E101	.99	12BA6	.64	1641	1.79
2E102	.99	12BA7	.64	1642	1.79
2E103	.99	12BE6	.64	1644	1.79
2E104	.99	12BH7	.89	1851	1.79
2E105	.99	12CS7	.89	1852	1.79
2E106	.99	12SC7	.89	1908	1.79
2E107	.99	12SG7	.89	2050W	1.79
2E108	.99	12SH7	.89	2051	1.79
2E109	.99	12SK7	.89	5R4GY	1.79
2E110	.99	12SN7	.89	5U4G	1.79
2E111	.99	12SR7	.89	5V4G	1.79
2E112	.99	12SW7	.89	5Y3GT	1.79
2E113	.99	12SX7	.89	6AL5	1.79
2E114	.99	12SY7	.89	6AQ5	1.79
2E115	.99	14A7	.89	6AT6	1.79
2E116	.99	14B6	.89	6AU6	1.79
2E117	.99	14E7	.89	6AV6	1.79
2E118	.99	14R7	.89	6AX5	1.79
2E119	.99	14W7	.99	6BA6	1.79
2E120	.99	14Y7	.89	6BE6	1.79
2E121	.99	25L6	.64	6BQ5	1.79
2E122	.99	26Z6	.89	6C4	1.79
2E123	.99	25Z6	1.79	6CB6	1.79
2E124	.99	25Z6G	.89	6CD6	1.79
2E125	.99	35Z3	.81	6DQ6	1.79
2E126	.99	35Z5	.89	6E5	1.79
2E127	.99	35Y4	.69	6F6	1.79
2E128	.99	50A5	.89	6F8G	1.79
2E129	.99	50B5	.89	6G6	1.79
2E130	.99	50C5	.89	6J6	1.79
2E131	.99	50L6	.89	6K6	1.79
2E132	.99	75	.69	6K7	1.79
2E133	.99	78	.69	6K8	1.79
2E134	.99	80	.69	6L6	1.79
2E135	.99	83V	.99	6L7	1.79
2E136	.99	85A1	1.39	6N7	1.79
2E137	.99	85A2	1.39	6Q7	1.79
2E138	.99	85A3	1.39	6S4	1.79
2E139	.99	85B1	1.39	6SA7	1.79
2E140	.99	85B2	1.39	6SC7	1.79
2E141	.99	85B3	1.39	6SF5	1.79
2E142	.99	85C1	1.39	6SG7	1.79
2E143	.99	85C2	1.39	6SH7	1.79
2E144	.99	85C3	1.39	6SK7	1.79
2E145	.99	90C1	1.39	6SL7	1.79
2E146	.99	90C2	1.39	6SN7	1.79
2E147	.99	90C3	1.39	6SQ7	1.79
2E148	.99	95	.89	6V6	1.79
2E149	.99	99	.89	6W4	1.79
2E150	.99	100TH	1.30	6X4	1.79
2E151	.99	100TL	1.30	6X5	1.79
2E152	.99	211	1.30	6Y6	1.79
2E153	.99	250TH	19.50	6Z4	1.79
2E154	.99	250TL	19.50	7A4	1.79
2E155	.99	807	.89	7A5	1.79
2E156	.99	807W	.89	7A6	1.79
2E157	.99	808	4.90	7A7	1.79
2E158	.99	809	2.50	7B5	1.79
2E159	.99	811A	3.94	7B6	1.79
2E160	.99	812	2.50	7C4	1.79
2E161	.99	813	2.50	7C5	1.79
2E162	.99	814	2.50	7C6	1.79
2E163	.99	829	1.79	7C7	1.79
2E164	.99	832	1.79	7E5	1.79
2E165	.99	832A	1.79	7E6	1.79
2E166	.99	866A	1.79	7F7	1.79
2E167	.99	872A	1.79	7G7	1.79
2E168	.99	931A	1.79	7H7	1.79
2E169	.99	1616	1.79	7N7	1.79
2E170	.99	1619	1.79	7S7	1.79
2E171	.99	1625	1.79	7V7	1.79
2E172	.99	1626	1.79	7W7	1.79
2E173	.99	1629	1.79	7X7	1.79
2E174	.99	1630	1.79	7Y4	1.79
2E175	.99	1631	1.79	7Z4	1.79
2E176	.99	1632	1.79	12A6	1.79
2E177	.99	1639	1.79	12AT6	1.79
2E178	.99	1641	1.79	12AU7	1.79
2E179	.99	1642	1.79	12AT7	1.79
2E180	.99	1644	1.79	12AV7	1.79
2E181	.99	1851	1.79	12AX4	1.79
2E182	.99	1852	1.79	12AX7	1.79
2E183	.99	1908	1.79	12AY7	1.79
2E184	.99	2050W	1.79	12BA6	1.79
2E185	.99	2051	1.79	12BA7	1.79
2E186	.99	5R4GY	1.79	12BE6	1.79
2E187	.99	5U4G	1.79	12BH7	1.79
2E188	.99	5V4G	1.79	12CS7	1.79
2E189	.99	5Y3GT	1.79	12SC7	1.79
2E190	.99	6AL5	1.79	12SG7	1.79
2E191	.99	6AQ5	1.79	12SH7	1.79
2E192	.99	6AT6	1.79	12SK7	1.79
2E193	.99	6AU6	1.79	12SN7	1.79
2E194	.99	6AV6	1.79	12SR7	1.79
2E195	.99	6AX5	1.79	12SW7	1.79
2E196	.99	6BA6	1.79	12SX7	1.79
2E197	.99	6BE6	1.79	12SY7	1.79
2E198	.99	6BQ5	1.79	14A7	1.79
2E199	.99	6C4	1.79	14B6	1.79
2E200	.99	6CB6	1.79	14E7	1.79
2E201	.99	6CD6	1.79	14R7	1.79
2E202	.99	6DQ6	1.79	14W7	1.79
2E203	.99	6E5	1.79	14Y7	1.79
2E204	.99	6F6	1.79	25L6	1.79
2E205	.99	6F8G	1.79	26Z6	1.79
2E206	.99	6G6	1.79	25Z6	1.79
2E207	.99	6J6	1.79	25Z6G	1.79
2E208	.99	6K6	1.79	35Z3	1.79
2E209	.99	6K7	1.79	35Z5	1.79
2E210	.99	6K8	1.79	35Y4	1.79
2E211	.99	6L6	1.79	50A5	1.79
2E212	.99	6L7	1.79	50B5	1.79
2E213	.99	6N7	1.79	50C5	1.79
2E214	.99	6Q7	1.79	50L6	1.79
2E215	.99	6S4	1.79	75	1.79
2E216	.99	6SA7	1.79	78	1.79
2E217	.99	6SC7	1.79	80	1.79
2E218	.99	6SF5	1.79	83V	1.79
2E219	.99	6SG7	1.79	85A1	1.79
2E220	.99	6SH7	1.79	85A2	1.79
2E221	.99	6SK7	1.79	85A3	1.79
2E222	.99	6SL7	1.79	85B1	1.79
2E223	.99	6SN7	1.79	85B2	1.79
2E224	.99	6SQ7	1.79	85B3	1.79
2E225	.99	6V6	1.79	85C1	1.79
2E226	.99	6W4	1.79	85C2	1.79
2E227	.99	6X4	1.79	85C3	1.79
2E228	.99	6X5	1.79	90C1	1.79
2E229	.99	6Y6	1.79	90C2	1.79
2E230	.99	6Z4	1.79	90C3	1.79
2E231	.99	7A4	1.79	95	1.79
2E232	.99	7A5	1.79	99	1.79
2E233	.99	7A6	1.79	100TH	1.79
2E234	.99	7A7	1.79	100TL	1.79
2E235	.99	7B5	1.79	211	1.79
2E236	.99	7B6	1.79	250TH	1.79
2E237	.99	7C4	1.79	250TL	1.79
2E238	.99	7C5	1.79	807	1.79
2E239	.99	7C6	1.79	807W	1.79
2E240	.99	7C7	1.79	808	1.79
2E241	.99	7E5	1.79	809	1.79
2E242	.99	7E6	1.79	811A	1.79
2E243	.99	7F7	1.79	812	1.79
2E244	.99	7G7	1.79	813	1.79
2E245	.99	7H7	1.79	814	1.79
2E246	.99	7N7	1.79	829	1.79
2E247	.99	7S7	1.79	832	1.79
2E248	.99	7V7	1.79	832A	1.79
2E249	.99	7W7	1.79	866A	1.79
2E250	.99	7X7	1.79	872A	1.79
2E251	.99	7Y4	1.79	931A	1.79
2E252	.99	7Z4	1.79	1616	1.79
2E253	.99	12A6	1.79	1619	1.79
2E254	.99	12AT6	1.79	1625	1.79
2E255	.99	12AU7	1.79	1626	1.79
2E256	.99	12AT7	1.79	1629	1.79
2E257	.99	12AV7	1.79	1630	1.79
2E258	.99	12AX4	1.79	1631	1.79
2E259	.99	12AX7	1.79	1632	1.79
2E260	.99	12AY7	1.79	1639	1.79
2E261	.99	12BA6	1.79	1641	1.79
2E262	.99	12BA7	1.79	1642	1.79
2E263	.99	12BE6	1.79	1644	1.79
2E264	.99	12BH7	1.79	1851	1.79
2E265	.99	12CS7	1.79	1852	1.79
2E266	.99	12SC7	1.79	1908	1.79
2E267	.99	12SG7	1.79	2050W	1.79
2E268	.99	12SH7	1.79	2051	1.79
2E269	.99	12SK7	1.79	5R4GY	1.79
2E270	.99	12SN7	1.79	5U4G	1.79
2E271	.99	12SR7	1.79	5V4G	1.79
2E272	.99	12SW7	1.79	5Y3GT	1.79
2E273	.99	12SX7	1.79	6AL5	1.79
2E274	.99	12SY7	1.79	6AQ5	1.79
2E275	.99	14A7	1.79	6AT6	1.79
2E276	.99	14B6	1.79	6AU6	1.79
2E277	.99	14E7	1.79	6AV6	1.79
2E278	.99	14R7	1.79	6AX5	1.79
2E279	.99	14W7	1.79	6BA6	1.79
2E280	.99	14Y7	1.79	6BE6	1.79
2E281	.99	25L6	1.79	6BQ5	1.79
2E282	.99	26Z6	1.79	6C4	1.79
2E283	.99	25Z6	1.79	6CB6	1.79
2E284	.99	25Z6G	1.79	6CD6	1.79
2E285	.99	35Z3	1.79	6DQ6	1.79
2E286	.99	35Z5	1.79	6E5	1.79
2E287	.99	35Y4	1.79	6F6	1.79
2E288	.99	50A5	1.79	6F8G	1.79
2E289	.99	50B5	1.79	6G6	1.79
2E290	.99	50C5	1.79	6J6	1.79
2E291	.99	50L6	1.79	6K6	1.79
2E292	.99	75	1.79	6K7	1.79
2E293	.99	78	1.79	6K8	1.79
2E294	.99	80	1.79	6L6	1.79
2E295	.99	83V	1.79	6L7	1.79
2E296	.99	85A1	1.79	6N7	1.79
2E297	.99	85A2	1.79	6Q7	1.79
2E298	.99	85A3	1.79	6S4	1.79
2E299	.99	85B1	1.79	6SA7	1.79
2E300	.99	85B2	1.79	6SC7	1.79
2E301	.99	85B3	1.79	6SF5	1.79
2E302	.99	85C1	1.79	6SG7	1.79
2E303	.99	85C2	1.79	6SH7	1.79
2E304	.99	85C3	1.79	6SK7	1.79
2E305	.99	90C1	1.79	6SL7	1.79
2E306	.99	90C2	1.79	6SN7	1.79
2E307	.99	90C3	1.79	6SQ7	1.79
2E308	.99	95	1.79	6V6	1.79
2E309	.99	99	1.79	6W4	1.79
2E310	.99	100TH	1.79	6X4	1.79
2E311	.99	100TL	1.79	6X5	1.79
2E312	.99	211	1.79	6Y6	1.79
2E313	.99	250TH	1.79	6Z4	1.79
2E314	.99	250TL	1.79	7A4	1.79
2E315	.99	807	1.79	7A5	1.79
2E316	.99	807W	1.79	7A6	1.79
2E317	.99	808	1.79	7A7	1.79
2E318	.99	809	1.79	7B5	1.79
2E319	.99	811A	1.79	7B6	1.79
2E320	.99	812	1.79	7C4	1.79
2E321	.99	813	1.79	7C5	1.79
2E322	.99	814	1.79	7C6	1.79
2E323	.99	829	1.79	7C7	1.79
2E324	.99	832	1.79	7E5	1.79
2E325	.99	832A	1.79	7E6	1.79
2E326	.99	866A	1.79	7F7	1.79
2E327	.99	872A	1.79	7G7	1.79
2E328	.99	931A	1.79	7H7	1.79
2E329	.99	1616	1.79	7N7	1.79
2E330	.99	1619	1.79	7S7	1.79
2E331	.99	1625	1.79	7V7	1.79
2E332	.99	1626	1.79	7W7	1.79
2E333	.99	1629	1.79	7X7	1.79
2E334	.99	1630	1.79	7Y4	1.79
2E335	.99	1631	1.79	7Z4	1.79
2E336	.99	1632	1.79	12A6	1.79
2E337	.99	1639	1.79	12AT6	1.79
2E338	.99	1641	1.79	12AU7	1.79
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2E340	.99	1644	1.79	12AV7	1.79
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ASD	SO-1	SCR584

* COMPONENTS. † LORAN EQUIPMENT

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3C1084H-48	3C1084Z-74-3	2Z5822-581
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			500	.050	
			500	.250	
DA-1A*	28	10	150	.010	3.98
			14.5	5.	
PE 73CM	28	15	1000	.350	16.50
BD 65‡	14	2.8	220	.55	8.95
DAG-33A	13	3.2	450	.06	2.50
DM25†	12	2.3	250	.85	6.95
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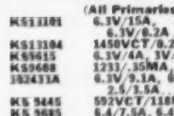

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KS9685	1233/.35MA, 1146VCT/.07A	5.79
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KS 5445	592VCT/116MA, 6.3V/3.1A, 5V/2A	5.30
KS 5685	6.4/7.5A, 6.4V/1.8A, 6.4/2.5A ALL CT	4.79
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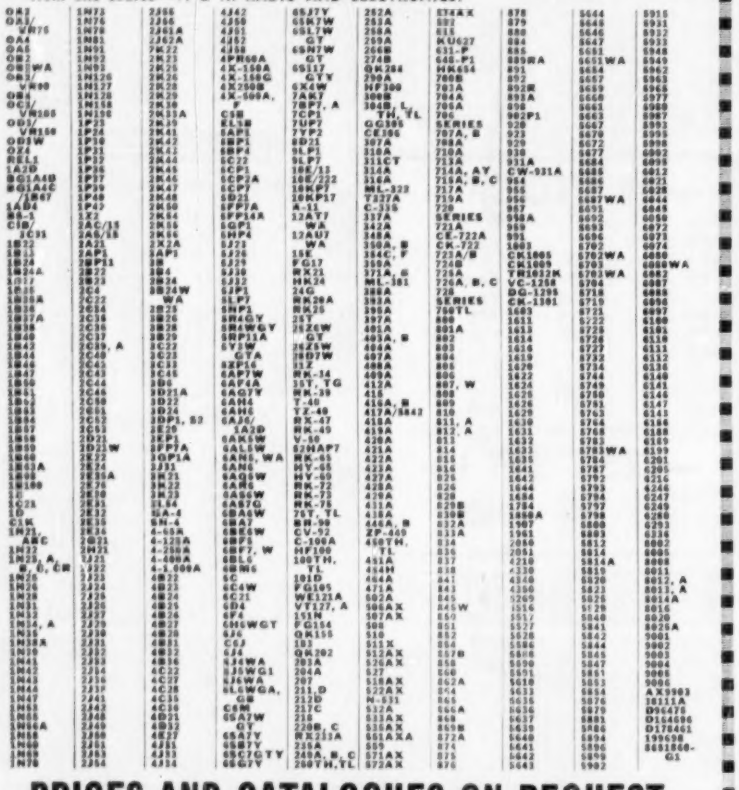

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10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **$35.00**

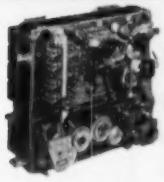
PE109 Leland
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

PE218 Leland
Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. **$30.00**

MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; Input: 24 VDC @ 36 amps. **$40.00**

MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts — 400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **$95.00**

DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **$39.50**



PARALLAX COMPUTER used with B29

sighting station; approximate dimensions 18" x 19" x 10"; approximate weight 100 lbs.
Contains:
Servo amplifier
7-24VDC Gearhead Motors
6-400 cy. Selsyns
Position Analyzer
Many mechanical differentials
Hundreds of precision gears
Relays

Government cost approximately **$8000.00**
Our price .....**$ 100.00**

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2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 Cont. Trans. 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57 5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
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5D Diff. Mtr. 90/90V 60 cy.	34.50
5DG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
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R235-1A Kearfott Resolver 26/11 8V 400 cy.	22.50
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C69406 Syn. Transm. 115V 60 cy.	20.00
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C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 32V 60 cy.	7.50
403 Kollsman Autosyn Mtr. 32V 60 cy.	7.50
CK5 Bendix Mtr. 2 phase 26V 400 cy.	17.50
FPE-43-1 Resolver 400 cy.	25.00
FIE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
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2900 Transicoil 115V 400 cy.	15.00

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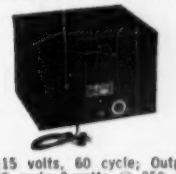
Model AW 0-1 MA

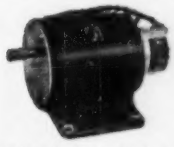
DC Milliameter permanent magnet moving coil type. Spring clock duel speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument.
Portable case **$200.00**

TELEGON OSCILLATOR



Input: 115 volts, 60 cycle; Output: 26.5 volts, 400 cycle 3 watts @ 250 ohm load. Ideal for laboratory use ... approx. 10" x 7" x 8", wt. 16 lbs.....**$29.95**

PIONEER TORQUE UNITS



Type 12602-1-A. Includes CK 5 Servo motor coupled to output shaft thru 125:1 gear reduction train. Output shaft coupled to autosyn follow-up (AY-43). Ratio of output shaft to follow-up autosyn is 30:1 Includes base mounting type cover for motor and gear train.....**$34.95**

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(approx. size overall 3¾" x 1¼" dia.)	
5069600 Delco PM 27.5 VDC 250 rpm	$12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w/brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
MM A-11 Globe PM 24 VDC	7.50
5BA10AJ18 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1¼" in dia. 2" long overall	4.00

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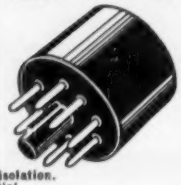
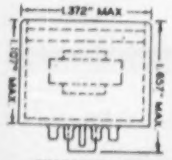
PULSE TRANSFORMER PT-3

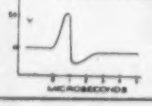
TUBE BASE PLUG-IN TYPE

Similar characteristics to UX 7350. Precision-made. Two 100-turn and two 50-turn coils wound on high quality hypersil cores. Built into octal bakelite tube bases. Completely impregnated and sealed—humidity-resistant. Diagram on end disc of each unit provides versatility of application.





CHARACTERISTICS
Impedance, ohms 120
Rise time, microseconds .03
Drop in 1 microsecond 30%
2 microsecond 40%
5 microsecond 85%
10 microsecond 78%



THESE PT-3 TRANSFORMERS may be used

- In Blocking Oscillator, Multivibrator and Scope Circuits.
- For interstage coupling, impedance matching and isolation.
- Wherever accurate timing and triggering are essential.
- In circuit applications requiring the generation of low power and low voltage pulses.
- In circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths from .03 microsecond.

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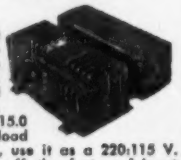

the factory price of a 1-input 2,000 VA unit! And here's another bonus! This Air Forces 2,000 VA overstock, Sola Cat. No. 30768, has 4 inputs! 90-125 V., 190-250 V., 60 cy. or 50 cy. Isolated secondary is constant 115.0 V. ± 1% from no-load to full-load of 17.4 amp. So, if you choose, use it as a 220:115 V. step-down. And slash $147.50 off the factory 1-input price!

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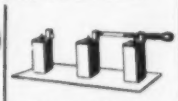
25KV	0.1	14.95	1000	2.0	.69
7.5KV	0.5	4.25	600	10.	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	★ .69
3KV	0.1	★1.19	600	2	★ .39
2.5KV	2.0	★2.95	600	1	★ .19
2KV	5.0	2.95	660AC	5	2.95
			330AC	5	1.29

SPECIAL SWITCHES

SW 141 ( ) DPST normally open with or without lock-in position on push button, part of CD-318 cord set

★.34¢



SW 244 SPDT Antenna change switch Square D Cat. No. 9320-962 SC #3ZK-9503 - 20 Bakelite Base 2x8x1/4

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Sensitive MU-Switch 15A. 125 V. AC 15/32-32 threaded bushing. SPST N.C.—44¢; SPST N.O.—49¢; SPDT—59¢

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10 Mfd 400 volts ★59c

Dual 5 mfd 3 term. bottom mount. Meets specs for 600 V operation at 40°C. 3¾x3½x2

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.001	A2L	2500WV	Thickness 1/4"	.49
.02	6S	2000WV		1.55
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		Carton Lot	Per Carton	Each
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6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.00	41.35
12	7.25	14.35	22.10	29.75	44.25
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Prf: 115V, 60 cycles input	2 Amps.	6.75
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OD3/VR150	.85	10D21	85.00	851	9.50
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1N34A	.65	FG95A	20.00	1000T	137.50
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1N64	.70	FG105	15.00	5517	2.15
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2J37	10.00	272A	9.00	5678	1.25
2J54	35.00	274B	1.00	5686	2.00
2K25	19.95	275A	3.50	5687	1.00
2K28	28.50	276D	8.50	5691	5.50
2K45	50.00	287A	3.00	5692	5.25
2K55	18.00	GL299	3.50	5693	4.75
3B23/RK22	4.00	304TH Surp.	8.75	5696	1.15
3B24	1.50	304TL Surp	10.75	5702	2.00
3B24/W	5.00	311A	5.50	5704	1.50
3B25	5.00	313C	2.50	5718	4.24
3B27	1.50	313CA	2.95	5819RCA	11.00
3B28	6.00	313CC	1.75	5820 Icon	185.00
3B29	6.00	337A	6.50	5726/GALSW	1.10
3C23	7.50	WE339A	14.00	5732	3.00
3C31/C1B	2.25	347A	3.25	5744	.90
3C45	7.50	350A (WE)	3.00	5749	2.00
3D21A	4.50	350R	2.75	5751	2.50
3J30	45.00	WE355A	17.50	5763	1.10
3J31	45.00	359A	2.00	5780	250.00
3BP1	2.95	391A	3.50	5787	5.75
3BP11	7.00	417A		5794	7.75
3DP1	5.00	Klystron	3.50	5795	396.00
4B24	5.00	429A	8.75	5814	1.20
4B28 6 Amp Rectigon	1.00	464A	2.55	5814A	2.00
4E27	9.50	CK503AX	1.00	5819	37.50
4J21	27.50	GL559	.50	5820	write
4J30	39.50	GL562	50.00	5829	2.00
4J35	75.00	WL-651S	110.00	5840	5.00
4J37	75.00	WL651/5552	50.00	5844	4.60
4J61	7.00	GL673	13.00	5879	1.25
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Surp	50.00	717A	.50	6073	1.65
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Surp	75.00	723A/B	9.50	6097	1.50
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.0015	10 KV	14.95	.02	3 KV	15.44
.0002	6 KV	12.18	.022	3 KV	15.44
.00024	6 KV	12.76	.05	1 KV	17.55
.00025	6 KV	12.76	.051	1.5 KV	18.31
.0004	6 KV	13.31	.08	1.5 KV	19.73
.0005	6 KV	14.00	.1	1.5 KV	20.28
.00062	6 KV	14.00			

G-2 (CM 80)

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.001	10 KV	19.67
.0002	10 KV	19.67	.002	10 KV	19.67
.00027	10 KV	19.67	.004	6 KV	19.67
.0003	10 KV	19.67	.006	6 KV	19.67
.00033	10 KV	19.67	.01	6 KV	20.75
.000375	10 KV	19.67	.02	3 KV	21.00
.0004	6 KV	19.67	.045	3 KV	21.00

G-3 (CM 85)

.00009	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.52
.0001	25 KV	37.80	.001224	15 KV	44.52
.00015	20 KV	37.80	.002	12 KV	42.35
.0002	20 KV	38.75	.0025	12 KV	45.00
.000225	20 KV	39.33	.006	10 KV	42.35
.0003	20 KV	39.33	.015	5 KV	42.35
.0004	20 KV	41.15	.016	7 KV	45.50
.00047	20 KV	41.15	.02	3 KV	45.50
.0005	20 KV	41.15	.05	3 KV	45.81
.00095	5 KV	42.35	.15	2.5 KV	45.81
.001	15 KV	42.35	.28	1.5 KV	45.81
.001	20 KV	43.50			

G-4 (CM 90)

.00025	30 KV	66.35	.0066	15 KV	75.68
.0003	30 KV	66.35	.0075	15 KV	75.68
.00032	25 KV	66.35	.0081	12 KV	75.68
.00032	30 KV	67.25	.01163	5 KV	34.95
.00045	30 KV	67.50	.02	10 KV	34.95
.001	25 KV	68.73	.022	6 KV	34.95
.001	30 KV	75.50	.02325	3 KV	34.95
.0015	25 KV	68.73	.02448	3 KV	34.95
.0016	25 KV	68.73	.03076	2.5 KV	34.95
.002	20 KV	71.50	.03356	2.5 KV	34.95
.0025	25 KV	71.50	.04228	2.5 KV	34.95
.003	20 KV	72.50	.04300	2 KV	34.95
.0039	20 KV	72.50	.05	5 KV	62.50
.004	20 KV	72.50	.056	5 KV	63.17
.004444	15 KV	73.62	.05648	2 KV	34.95
.006	16 KV	75.68	.06808	1.5 KV	34.95

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2)	5800 ohms	3A	4 MA	2.50 ea.
3)	5800 ohms	2B-1C	5 MA	2.50 ea.
4)	4850 ohms	1C	4 MA	2.50 ea.
4)	3600 ohms	1C	6 MA	2.00 ea.
5)	4550 ohms	1A	5 MA	2.00 ea.
6)	3300 ohms	(None)	ACTUATOR	3.50 ea.
7)	3300 ohms	1A	Micro-Switch	2.50 ea.
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.25	20	15.95
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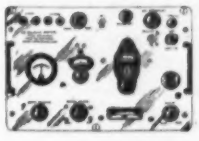

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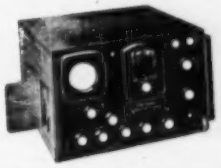

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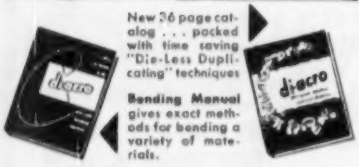
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INDEX TO ADVERTISERS

Acme Wire Co. 356
Aeronautical Communications Equipment, Inc. 257
Aerovox Corp. 281
Ainsile Corp. 343
Airborne Instruments Laboratory 80
Aircraft Radio Corp. 322
Aircraft-Marine Products, Inc. 35
Airpax Products Co. 89
Allen-Bradley Co. 273
Allen Co., Inc., L. B. 382
Allen Manufacturing Co. 376
Allegheny Ludlum Steel Corp. 303
American Airlines, Inc. 271
American Electric Motors, Inc. Electric Machinery & Equipt. Div. of American Electronics, Inc. 274
American Gas Furnace Co. 357
American Lava Corporation 115
American Phenolic Corp. 178
American Television & Radio Co. 380
American Time Products, Inc. 241
Amperite Co., Inc. 286
Ampex Corporation 83
Andersen Laboratories, Inc. 341
Andrew Corporation 344
Arnold Engineering Co. 13
Assembly Products, Inc. 64A-64B
Augat Bros., Inc. 358
Automatic Manufacturing Corp. 112
Avien, Inc. 375

Bakelite Co., a Div. of Union Carbide and Carbon Corp. 84, 85, 231
Ballantine Laboratories, Inc. 206
Barker & Williamson, Inc. 194
Barry Controls, Inc. 21
Bausch & Lomb Optical Co. 38
Belden Manufacturing Co. 68
Bell Telephone Laboratories 233
Bendix Aviation Corporation
Eclipse-Pioneer Div. 292
Pacific Div. 215
Scintilla Div. 324
Bentley, Harris Mfg. Co. 32
Berkeley Division, Beckman Instruments, Inc. 233
Bird Electronics Corp. 336
Boehme, Inc., H. O. 369
Boonton Radio Corp. 193
Borg Corporation, George W. 346
Bosworth & Co. 382
Brush Electronics Company 246
Budd-Stanley Co., Inc. 106
Burnell & Co., Inc. 67
Busmann Mfg. Co. 86

Caledonia Electronics Transformer Corp. 358
Calidyne Company, The 208
Cambridge Thermionic Corp. 263
Carter Motor Co. 339
Centralab, Div. of Globe-Union, Inc. 64
Cerf & Co., Art 382
Chase Brass & Copper Co. 261
Chatham Electronics, Div. of Gero Corp. 251
Chicago Standard Transformer Corp. 290
Chicago Telephone Supply Corp. 41
Cinch Mfg. Corp. 109
Clare & Co., C. P. 51
Clevite Transistor Products 279
Cleveland Container Co. 247
Clifton Precision Products Co., Inc. 105
Cohn Corp., Sigmund 352
Collectron Corporation 370
Color Television Inc. 345
Colortone Electronics Inc. 374
Commonwealth of Puerto Rico 277
Communication Accessories Co. 45
Communication Measurements Laboratory, Inc. 430
Computer Measurements Corp. 378
Condenser Products Div. of New Haven Watch & Clock Co. 378
Conrad Inc. 342
Consolidated Vacuum Corp. 316
Constantin & Co., L. L. 299
Constantine Engineering Laboratories Co. 192
Continental-Diamond Fibre, Div. of the Budd Company, Inc. 227
Cornell-Dubilier Electric Corp. 97
Corning Glass Works 288
Cosmic Condenser Co. 372
Craig Systems, Inc. 298
Cramer Co., Inc., R. W. 204
Cross Co., H. 307
Crucible Steel Co. of America 199
Cubic Corporation 335
Cunningham Son & Co., Inc., James 372
Curtiss-Wright Corp. 224

Dano Products Co. 307
Daubert Chemical Co. 356
Daven Company ..... 3rd Cover
Davies Laboratories, Inc. 331
DeJur-Amsco Corporation 296
Delco Radio Div. of General Motors 198
DeMorney-Bonardi 377
Dialight Corporation 347
Donner Scientific Co. 282

Dumont Airplane & Marine Instruments, Inc. 429
Du Mont Laboratories Inc., Allen B. 185
DuPont de Nemours & Co., (Inc.) Polychemicals Dept. 91

Eastern Industries, Inc. 58
Eastman Kodak Company 179
Edison Inc., Thomas A. 238
Eisler Engineering Co., Inc. 363
Eitel McCullough, Inc. 65
Elco Electronics Ltd. 375
Eleo Corp. 368
Electrical Industries, Div. of Amperex Electronic Corp. 93
Electrical Testing Laboratory, Inc. 351
Electro Impulse Laboratory 380
Electro Tec Corp. 267
Electronic Associates, Inc. 216
Electronic Instrument Co., Inc., (EICO) 343
Emerson & Cuming Inc. 318
Engineering Co., The 340
Epsco, Inc. 313
Erie Resistor Corp. 39
Essex Wire Corp., R-B-M Div. 184

Falcon Electronics Corp. 432
Fansteel Metallurgical Corp. 308, 309
Farnsworth Electronics Co. 71
Federal Telephone & Radio Co. 75, 373
Ferroxcube Corp. of America 307
Filtors, Inc. 374
Ford Instrument Co., Div. Sperry Rand Corp. 242
Formica Company 223
Freed Transformer Co., Inc. 275
Frenchtown Porcelain Company 376
Frequency Standards 295
F-R Machine Works Inc. 235
Furst Electronics, Inc. 433

G M Laboratories, Inc. 29, 354
Gabriel Electronics Div. of Gabriel Co. 306
Gamewell Co. 230
Garfield Wire Div. of the Overlakes Corp. 368
Gee-Lar Manufacturing Company 328
General Cable Corp. 217
General Dry Batteries Inc. 188
General Electric Company
Apparatus Dept. 76, 77, 78, 79, 108, 109
Electronics Dept. 33
Tube Dept. 23, 94, 95
General Industries Co. 221
General Radio Co. 17
General Research & Supply Co. 328
Genisco Incorporated 339
Gertsch Products Inc. 360

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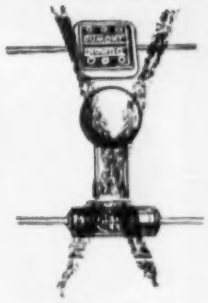

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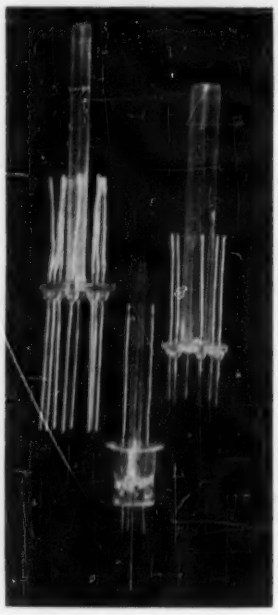

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Good-all Electric Mfg. Co. 283
Greenleaf Manufacturing Co. 55
Gries Reproducer Corp. 365

Hammarlund Mfg. Co., Inc. 35
Harvey Hubbel, Inc. 82
Hayden Associates, Paul 382
Haydon Manufacturing Co., Inc. 248
Haydu Brothers of New Jersey 285
Heath Co. 350
Helipot Corp., Div. of Beckman Instruments, Inc. 175
Hetherington, Inc. 196
Hewlett-Packard Co. 51
Heyman Manufacturing Co. 369
Homelite a div. of Textron American, Inc. 367
Hughes Aircraft Co. 180, 181
Hughes Research & Development Laboratories 332
Hunt Company Philip A. 250
Hycor Company, Inc. 371
Hycon Eastern, Inc. 240
Hycon Electronics, Inc. 252

Ilsco Corporation 336
Industrial Development Committee of 100, Lakeland, Florida 352
Industrial Test Equipment Co. 377
Industrial Timer Corp. 40
Institute of Radio Engineers 201
International Business Machines 320
International Rectifier Corp 34
International Resistance Co. 100, 101
Ippolito & Co., Inc., James 354

Jet Propulsion Laboratory 327, 365
J F D Electronics Corp. 42
Johnson Company E. F. 355
Jones Div., Howard B., Cinch Mfg. Co. .. 304
Jones Electronics Co., Inc., M. C. 278

Kahle Engineering Co. 15
Kaiser Metal Products Inc. 92
Kay Electric Co. 27
Kearfott Company, Inc. 312
Kellogg Company, M. W. 211
Kepco Laboratories 173
Kester Solder Co. 219
Koch Fiberglas 114
Kollsman Instrument Corp. 87

L M Electronics, Inc. 338
Laboratory for Electronics, Inc. 197
Lampkin Laboratories, Inc. 307
Land-Air, Inc. 366
Langevin Manufacturing Corp. 262
Lapp Insulator Co., Inc. 202
Lewis & Kaufman Ltd. 207
Linde Air Products Company, Div. of Union Carbide & Carbon Corp. 304
Litton Engineering Laboratories 362
Lockheed Missile Systems Div. 232
Loral Electronics Corp. 291
Los Alamos Scientific Laboratory of the University of California 254

MacDonald Inc., Samuel K. 382
Magnatran, Inc. 370
Magnetic Amplifiers, Inc. 302
Magnetics, Inc. 183
Mallory and Co., Inc., P. R. 120, 171
Mansol Ceramics Co. 186
Marconi Instruments, Ltd. 104
Marion Electrical Instrument Co. 32A, 32B, 294, 304
Markem Machine Co. 360
Mark Products 356
Martin Company, Glenn L. 276
Maxson Instruments 323
McLean Engineering 294
Metal & Thermit Corporation 280
Metals & Controls Corp., General Plate Div. 60
Mfgrs. Representatives 382
Mica Insulator Co. 215
Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co. 74
Mid-Century Instrument Co. 44
Midwestern Instruments 243
Millen Mfg. Co., Inc., James 222
Minneapolis-Honeywell Regulator Co., Industrial Div. 50
Mona Industries, Inc. 374
Monsanto Chemical Co. 53
Muirhead & Co., Ltd. 5
Mullard Overseas Ltd. 90

N J E Corporation 119
Naresco Equipment Corp., Sub. of National Research Corp. 239
National Semiconductor Products 107
New Hampshire Ball Bearings, Inc. 236
New Hermes Engraving Machine Corp. 373
Newhope Corporation 382
Nopco Chemical Co. 43
Norden-Ketay Corp. 195
Northern Radio Co., Inc. 56
Nothelfer Winding Labs, Inc. 54

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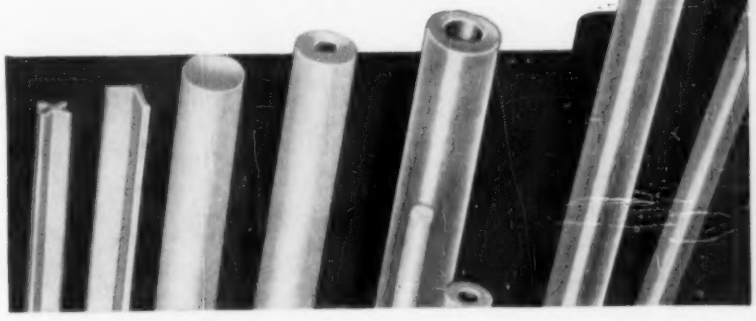

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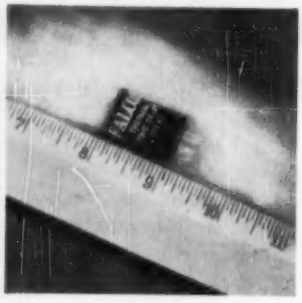

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DC INPUT CONNECTIONS: Two posts for push-pull or differential, one post connected to ground; for single-ended signals, other input is disabled by setting attenuator to "off" position

AC INPUT CONNECTIONS: Arranged like DC connections; signal terminals connected to DC terminals through coupling condensers

OUTPUT IMPEDANCE: Approx. 230 Ohms single-ended, approx. 120 Ohms push-pull. Minimum load resistance; 250 Ohms

UNDISTORTED OUTPUT: 20 volts or 5 Milliamperes (peak) max.

NOISE AND HUM: Below 40 microvolts referred to input

MOUNTING: Meta cabinet, 8" wide by 8" high by 13" deep

POWER CONSUMPTION: 120 watts from 115 volt 50-60 cycle, single-phase a.c. power line

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O'Neil-Irwin Mfg. Co. 428
Oregon Electronics 321

PM Industries, Inc. 317
Pacific Scientific Co. 319
Panoramic Radio Products, Inc. 300
Perkin-Elmer Corporation 226
Perkin Engineering Corp. 81
Phalo Plastics Corp. 256
Phaostron Instrument & Electronic Company 329
Phelps-Dodge Copper Products Corp., Inca Mfg. Div. 72, 73
Philamon Laboratories, Inc. 187
Phillips Process Co., Inc. 340
Photographic Products, Inc. 304
Polarad Electronics Corporation 61, 98, 229
Polytechnic Research & Development Co., Inc. 272
Popper & Sons, Inc. 379
Potter & Brumfield Mfg. Co. 36, 37
Precision Apparatus Co., Inc. 433
Precision Paper Tube Co. 214
Progressive Mfg. Co. 258
Pye Limited 209
Pyramid Electric Company 103

R. B. M. Division, Essex Wire Corp. 184
Radiation, Inc. 379
Radio Condenser Co. 237
Radio Corporation of America ..... 116, 117, 249, 4th Cover
Radio Engineering Laboratories, Inc. 255
Radio Engineering Products 342
Radio Materials Corp. 110
Radio Receptor Company, Inc. 118
Railway Express Agency, Air Express Div. 265
Rawson Electrical Instrument Co. 376
Raytheon Mfg. Co. 18, 19, 113
Reeves-Hoffman Corp. 347
Reeves Instruments Corp. 259
Relay Sales 182
Reliance Mica Co., Inc. 272
Revere Copper & Brass, Inc. 225
Roller-Smith Corp. 191
Rowe Engravers 382
Rutherford Electronics Co. 264

Sanborn Company 361
Sanders Associates, Inc. 362
Sangamo Electric Co. 294

Scovill Manufacturing Company 325
Scientific Electronic Labs 430
Scintilla Div., Bendix Aviation Corp. 324
Sealectro Corp. 260
Shasta, Division Beckman Instruments, Inc. 357
Sierra Electronic Corp. 264
Sigma Instruments, Inc. 284
Signal Engineering & Mfg. Co. 353
Simmons Fastener Corp. 88
Sorensen & Co., Inc. 4
South Chester Corp. 46
Southern Electronics Co. 234
Sprague Electric Co. 11, 177, 212, 344
Stackpole Carbon Co. 53
Stevens Arnold, Inc. 382
Stoddard Aircraft Radio Co., Inc. 228, 330
Stokes Machine Co., F. J. 62, 63
Stupakoff Ceramic & Manufacturing Co. Div. of the Carborundum Co. 310, 311
Superior Electric Company 203
Superior Tube Co. 99
Switchcraft, Inc. 363
Sylvania Electric Products, Inc. 9, 269
Syntronic Instruments, Inc. 364

Taylor Fibre Co. 253
Technicraft Laboratories, Inc. 326
Technology Instrument Corp. 337
Teiner Engineering Corp. 346
Tektronix, Inc. 245
Telechrome, Inc. 289
Tele Coil Co., Inc. 377
Tel-Instrument Electronics Corp. 353
Telonic Industries 338
Tensolite Insulated Wire Co., Inc. 270
Transradio, Ltd. 341
Triplett Electrical Instrument Co. 111
Tru-Ohm Products, Div. of Model Engineering & Mfg. Co. 189
Tung-Sol Electric, Inc. 205

Ucinite Co., The 48
Union Carbide and Carbon Corp.
Bakelite Co. 84, 85, 231
Union Switch & Signal, Div. of Westinghouse Air Brake Co. 314, 315
United Air Lines 349
United-Carr Corporation 49
United States Gasket Co. 421
United Transformer Co. ..... 2nd Cover
Unitek Corp. 359
Universal Winding Company 96

Vacuum Metals Corp. 66
Varian Associates 102
Veeder-Root, Inc. 305
Vulcan Electric Co. 307

Waldes Kohinoor, Inc. 57
Ward Leonard Electric Co. 47
Waterman Products Co., Inc. 200
Waters Manufacturing, Inc. 361
Watlow Electric Mfg. Co. 345
Webster Chicago 59
Weckesser Co. 294
Wenco Manufacturing Co. 380
Westinghouse Electric Corp. 190, 297
Wheeler Insulated Wire Co., Inc., Div. of Sperry Rand Corp. 244
White Dental Mfg. Co., S. S. 210
Woods Aircraft Supply 361

Xcelite, Inc. 368

MANUFACTURER'S REPRESENTATIVES 382

PROFESSIONAL SERVICES 381

CLASSIFIED ADVERTISING
F. J. Eberle, Asst Mgr.

SEARCHLIGHT ADVERTISING ... 412-427
ADVERTISERS INDEX 410
EMPLOYMENT OPPORTUNITIES .. 383-412
ADVERTISERS INDEX 408

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Index to electronics

VOLUME XXVIII

January to December Issue Inclusive 1955

McGraw-Hill Publishing Company, 330 West 42nd St. New York 36

A

A-C bridge sorts ceramic capacitors 106 Jul
Accelerator, current regulator for van de Graaff .....151 Oct
Acoustic effects on components.....181 Mar
Acoustics, electronic sound absorption 188D Jun
Acoustics, microphone nomograph..172 Oct
Acoustical research, electronic switch for .....163 Oct
Adder, binary, tube.....151 Sept
ADF for small airport.....184D Jun
Adjustable power supply.....164 Nov
Aeronautical communications recommendation .....202D Sept
AEW planes keep continuous watch 178D Nov
AFC for f-m tuning.....180D Jun
Airborne interrogator spots location, Applegarth .....170 May
Airborne wave propagation laboratory with mast .....164D Aug
Air-conditioned shielded room....180D Dec
Aircraft antenna, a-m system tunes 152 Aug
Aircraft, autopilot magnetic servo amplifier .....208D May
Aircraft carrier, antennas, for.....174D Dec
Aircraft communications recommendations .....202D Sept
Aircraft, etched antenna for supersonic .....130 Jul
Aircraft, ice detector for.....142 Dec
Aircraft, magnetic audio amplifier..122 Sept
Aircraft models for avoiding radar..122 Jan
Aircraft, portable precision approach radar .....154 Oct
Aircraft, propagation laboratory..164D Aug
Aircraft, robot guidance system....162D Jul
Aircraft, TACAN navigation system 174D Oct
Aircraft, temperature indicator for engine .....129 Nov
Aircraft, testing electronic components .....181 Mar
Aircraft, transistor modulator for trainer .....126 Sept
Aircraft, weather mapping radar..178D Sept
Air Force scientists plot static direction in D-layer study.....178D Feb
Airplane models reveal how to avoid radar, Cole .....122 Jan
Air-powered tilt-table speeds chassis-mounting .....268D Apr
Air shield on air gun stops flying chips 246D Apr
Alarm, fog, microwave controlled..122 Jul
Alarm system, design of ultrasonic..106 Aug
Alfenol recording heads.....137 Jun
Alfenol sources .....208D Jun
Aligning tv receivers by pulse-cross display, Thomas .....184D Apr
Alignment, tv camera, one man...214D Dec
All-magnetic audio amplifier, Suozzi & Hooper .....122 Sept
Alloy improves magnetic recording, Lufcy & Heath.....137 Jun
All-pass amplifier, Woll.....155 Jul

Items for which the page reference is marked "D" are editorial material published monthly in Electrons at Work and Production Techniques.

Amplifier, see also type, audio, pulse, video, etc.
Amplifier, all-pass .....155 Jul
Amplifier, anode-dynode beam deflection .....122 Aug
Amplifier, audio, circuit design factors .....166 Apr
Amplifier, audio, magnetic.....122 Sept
Amplifier, booster, for uhf-tv.....112 Jul
Amplifier, d-c, criss-cross.....198D Aug
Amplifier, d-c, electronic chopper..192D Nov
Amplifier, d-c, for computer.....119 Jul
Amplifier, d-c, transistor chopper for 135 Apr
Amplifier-detector, infinite impedance 168D Aug
Amplifier, differential, for null detector 148 Aug
Amplifier for fast rise-fall pulses, Deming .....170 Sept
Amplifier, high power uhf-tv.....130 Apr
Amplifier, i-f, chassis design for..182D Aug
Amplifier, light, employs electroluminescence .....178D Feb
Amplifier, linear power, for sub.....124 Aug
Amplifier, logarithmic, for target discriminator .....118 Aug
Amplifier, low-noise input stage....147 Feb
Amplifier, magnetic, autopilot servo 208D May
Amplifier, pulse, cathode compensation .....156 Nov
Amplifier, stagger-tuned, design.....158 Jul
Amplifier, studio, for color television 154 Mar
Amplifier, transistor audio.....119 Jul
Amplifier, transistor, feedback-stabilized .....174 May
Amplifier, transistor, for analog computer .....119 Jul
Amplifier, transistor, performance..196D Feb
Amplifier, transistor power.....174D Sept
Amplifier, two-way repeater.....164 Jan
Amplifier, wideband uhf.....158 Dec
Amplifier, X-band receiving.....202D Apr
A-M system tunes aircraft antennas, Geiser .....152 Aug
Analog computer, see also computer
Analog computers simulate engines 214D May
Analog function multiplier, wide-band 160 Feb
Analyzer, servo testing.....172 Apr
Analyzer, spectrum, for crystals....160 Oct
Analyzer, spectrum, for mobile radio 180D Feb
Anesthesia, physiological monitor for 130 Oct
Anode-dynode beam deflection amplifier, Wolkstein & Kaiser.....132 Aug
Antenna, a-m system tunes aircraft..152 Aug
Antenna arrays insure flat-top communications .....174D Dec
Antenna, automobile reflection in vhf-tv .....166D Jul
Antenna, broadband horn.....188D Aug
Antenna, Empire State WOR-TV...214D Apr
Antenna, etched, for supersonic aircraft .....130 July
Antenna, f-m, inside a-m tower.....130 Aug
Antenna, fan-pencil radar.....142 May
Antenna for vhf direction finder...172 Feb
Antenna, helmet, pack-set using...150 Mar
Antenna, moon-tracking .....166D Aug
Antenna pattern measured by helicopter .....124 Nov
Antenna, sailboat, design of.....140 Jun
Antenna, spider, six direction.....180D Jun
Antenna system for missile telemetering, Hower & Wynn.....164 Jun
Approach radar, portable.....154 Oct
Array, see also antenna
Aseptic machine shop.....204D Oct
Astronomy, radio, as navigation aid 182D Jan
Astronomy, radio, spider antenna..180D Jun
Astronomy, spectrum analyzer for sun 178D Oct
Atmospheric research, balloons gather lightning information .....218D Oct
Atomic clock, cesium frequency standard .....180D Apr
Attenuation, see also attenuators
Attenuator, transmission test set....145 Dec
Audience survey techniques.....126 Jan
Audio amplifier circuit design factors 166 Apr
Audio amplifier, magnetic.....122 Sept
Audio amplifier, telephone repeater..164 Jan
Audio amplifier, transistor.....196D Feb
Audio amplifier, transistor power..174D Sept
Audio, improving mobile.....190D Oct
Audio, low-noise input stage for preamplifier .....147 Feb
Audio oscillator, L-C.....216D Mar
Audio oscillator has low distortion, Sulzer .....158 May
Audio-standard generator, Koustas..161 Dec
Audio tones control refinery operations, Van Wambeck .....130 Jan
Audio transmission gain test set.....145 Dec
Automatic a-c bridges sort ceramic capacitors, Upham .....106 Jul
Automatic belting of machine-fed components .....248D Nov.
Automatic blood pressure recorder will sound alarm .....178D Jun
Automatic colorimeter for tv color tubes, Stanford .....138 Dec
Automatic control, capacitor sorting.106 Jul
Automatic control, electronic weighing 152 Jun
Automatic control, extrusion of wire insulation .....244 Apr
Automatic control in refinery operation .....130 Jan
Automatic control, label counter...128 Oct
Automatic control, micrometer sorter 156 May
Automatic control, packaging basic circuits .....122 Dec
Automatic control, phase shifter for industrial .....188 Mar
Automatic control, variable-speed for motors .....162 Apr
Automatic damping improves tv monitor, Thomas, Demars & Jones...230D Mar

Automatic inspection for green-rot in eggs ..... 140 Jul
Automatic micrometer sorts insulating wafers, Fearon ..... 156 May
Automatic music-speech discriminator silences speaker, Roth..... 162D Aug
Automatic production, punch cards control job-lot assembly..... 122 Nov
Automatic programming cuts broadcasting costs, Smaller..... 135 Oct
Automatic recorder for complex impedances, Sharaf ..... 187 Sept
Automatic testing—mechanized production of electronic equipment..159 Sept
Automatic tuning of aircraft antenna 152 Aug
Automation, see automatic control
Automobile, headlight dimmer for..170 Mar
Automobile, power supply for 6 and 12 volts ..... 216D May
Automobile, radar speed meter..... 132 Dec
Automobile reflection in vhf-tv, Geist 166D Jul
Autopilot magnetic servo amplifier, Zucchino ..... 208D May

B

Balloons gather lightning information 218D Oct
Band-pass filters using strip-line techniques, Bradley and White..... 152 May
Baseline determined by geodimeter.194D Jul
Basic chassis for experimental work, Emslie ..... 166 Nov
Basic control circuits are packaged, Klivans ..... 122 Dec
Batching control, ... 157 Feb
Battery, solar, efficiency doubled ..182D Jun
Battery, solar, powers telephone..178D Nov
Beacon, radar, calibrator checks....150 Apr
Beam deflection amplifier tube.....132 Aug
Bevatron, generating r-f energy for..164 Feb
Beyond-horizon signals extend communications, Day ..... 122 Oct
Bias source, reactance voltage....218D Feb
Bias supply design for bolometers, Braun ..... 208D Oct
Binary-adder tube for high-speed computers, Maynard ..... 161 Sept
Binary counter, four decade frequency divider using ..... 154 Apr
Biology, electronic switch for..... 135 Dec
Biophysics, see medical electronics
Blackboard substitute ..... 248D Feb
Blimp, ice detector for..... 142 Dec
Blind, radar cane guides..... 208D Jun
Blood pressure recorder..... 178D Jun
Boat antennas, design of..... 140 Jun
Bolometer, bias supply design.....208D Oct
Booster amplifier for uhf-tv.....112 Jul
Bounce in relay contacts, measuring.137 Aug
Bovine gyrations measured electronically ..... 194D Jun
Brain surgery, ultrasonic substitute for lobotomy ..... 164D Jul
Breadboard, chassis for experimental work ..... 166 Nov
Bridged-T network, design of notch.172 Sept
British color tv tests..... 206D Sept
British tv tower..... 188D Nov
Broadband horn antennas..... 188D Aug
Broadcast, see also f-m television
Broadcast, antenna for WOR-TV..214D Apr
Broadcast, automatic programming..135 Oct
Broadcast, Canadian time signals 182D, 196D Jun
Broadcast, color-burst deviation meter 149 May
Broadcast, color-video envelope-delay measurement ..... 144 Jun
Broadcast, f-m antenna inside a-m tower ..... 130 Aug
Broadcast, feedback clamp circuit for tv ..... 182D Jul
Broadcast, high quality receiver for tv re- ..... 152 Dec
Broadcast, matrixing and encoding color ..... 140 Nov
Broadcast, multiplexing f-m..... 146 Oct
Broadcast, pulsed tones control a-m and f-m ..... 122 Sept
Broadcast receiver, Japanese transistor 174D Dec
Bradcast, tabulating radio-tv audience ..... 126 Jan
Broadcast, transmission test set..... 145 Dec
Broadcast, uhf re- ..... 131 May
Broadcast, video patch panel.....210D Apr
Broadcast, WOR master control 204D Sept
Broadcast receiver, transistorized portable ..... 159 Mar
Broadcast transmitter, fifty kw..... 168 Mar
Building potted amplifiers..... 250D Sept
Burglar alarm, design of ultrasonic..106 Aug
Business machine, computer as..... 122 Jun
Business machine, photoelectric reader 134 May

C

Cable plug wrench..... 264D May
Calculator, see computer
Calibrator checks radar beacons.....150 Apr
Calibrator, industrial microwave...168 Jun
Camera alignment, one man tv.....214D Dec
Camera, underwater television .....174D Sept
Canadian observatory broadcasts talking clock ..... 182D, 196D Jun
Cancer diagnosis, ultrasonic..... 174 Mar
Cancer research, cytoanalyzer..... 182D Apr
Cane, radar, for blind..... 208D Jun
Capacitance, see also capacitor
Capacitance transducer, single-tube 182D Oct
Capacitive transducer has low impedance, Kalmus ..... 161 Jun
Capacitor, a-c bridge sorts ceramic...106 Jul
Capacitor energy storage..... 216D Oct
Capacitor Production Techniques
Adhesive tape capacitors..... 233D Feb
Automatic sorting ..... 230D Sept
Installing electrolytics ..... 240D Sept
Limit bridge tests ten-at-a-time..224D Jun
Placing plastic tubing on metal-cased capacitors ..... 280D Apr
Card-controlled machines are thrice as productive ..... 178D Oct
Cathode compensation linearizes video stages, Millman & Taub..... 156 Nov
Cathode-follower detector ..... 168D Aug
Cathode-follower, improving frequency response ..... 190D Aug
Cathode-ray display of seismic recordings, Groenendyke and Loper.....160 May
Cathode-ray tube changes signal to letters ..... 182D May
Cathode-ray tube deflection circuit..146 Jul
Cathode-ray tube, flat..... 214D Mar
Cathode-ray tube, flat..... 186D Nov
Cavity, tunable X-band ..... 135 Jun
Ceramic capacitors sorted by a-c bridge ..... 106 Jul
Ceramic relay, electrostrictive..... 226D Mar
Cesium frequency standard controls accurate atomic clock..... 180D Apr
Characteristic, dynamic, triode-connected pentode ..... 208D Dec
Chart, dielectric mixture..... 176 Apr
Chart, linear reactor design..... 208 Mar
Chassis, basic for experimental work 166 Nov
Chassis design for i-f amplifiers, Linden ..... 182D Aug
Chemical analysis, tape-controlled..126 Feb
Chopper, electronic ..... 192D Nov
Chopper, transistor, for d-c amplifier.135 Apr
Choppers, design trends in..... 150 Feb
Circuit design factors for audio amplifiers, Kiebert ..... 166 Apr
Circuit standards, preferred..... 182D Nov
Circuit, transistor switching..... 168 Jan
Clamp circuit, feedback, for tv....182D Jul
Closed-circuit television adds eyes in sawmill ..... 214D Mar
Coaxial coupler for uhf multiplexer.152 Nov
Coaxial filter, band-pass using a strip line ..... 152 May
Coil Production Techniques
Applying varnish to coil with pressurized hypo ..... 228D Nov
Die-casting cuts cost..... 222D Jul
One-way pallet-return conveyor 224D Dec
Toothpick screwdrivers for fragile cores ..... 222D Dec
Winding coils on lathe..... 274D Feb
Color-burst, meter for deviation of..149 May
Color computer ..... 166 Oct
Colorimeter for color television tube 138 Dec
Color television, see also television
Color teelvision, colorimeter for.....138 Dec
Color television, computer for color curves ..... 166 Oct
Color television, differential gain test 114 Aug
Color television, flying spot pickup..176D Jul
Color television, matrixing and encoding ..... 140 Nov
Color television, phase measurement.142 Feb
Color television, studio amplifier for.154 Mar
Color transparencies aid assembly..234D Jul
Color tv, British..... 206D Sept
Color tv pallet design..... 318D Mar
Color-video envelope-delay measurement, Kennedy & French..... 144 Jun
Colpitts oscillator, producing oscillations with ..... 184D May
Communications, designing links....126 Dec
Communication, electronics markets.128 Apr
Communication, mobile radio squelch circuit ..... 143 Jul
Communication, power amplifier for ssb ..... 124 Aug
Communications, aircraft recommendations ..... 202D Sept
Communications, beyond horizon signals extend ..... 122 Oct
Communications, design of boat antennas ..... 140 Jun
Communications, designing components for 2,000 mc..... 186D May
Communications, improving mobile radio ..... 156 Jun
Communications, parts speeded by radio ..... 176D Nov
Communications, series-tube modulator 158 Nov
Communications, single-tone calling for mobile ..... 144 May
Comparator for small phase angles Nilsen & Tufte..... 188D Jan
Compensated squelch for mobile radio receivers, Hargreaves ..... 142 Jul
Compensation, cathode, for video stages ..... 156 Nov
Complex impedance recorder..... 167 Sept
Component design trends—Metallic rectifiers approach infinite life....162 Mar
Component design trends—New relay materials improve performance....144 Jan
Component design trends—special-purpose relays gain new uses..... 150 Feb
Component preparation—mechanized production of electronic equipment 141 Sept
Components, design for uhf..... 186D May
Components, testing airborne..... 181 Mar
Computer, analog, color..... 166 Oct
Computer, analog, transistor amplifiers for ..... 119 Jul
Computer, binary adder tube for...161 Sept
Computer-controlled stabilizing fin..212D Nov
Computer, d-c transistor circuits..... 132 Jun
Computer, data reduction for missiles 126 May
Computer, ferrite-core memory.....194 Mar
Computer, flying-spot function generator ..... 149 Jun
Computer, for ram jet engine tests.180D Jun
Computer, modulator for flight trainer 126 Sept
Computer, photoelectric reader..... 134 May
Computer, square-law circuit.....192D Sept
Computer storage systems..... 122 Jun
Computer, synchronizing drum storage speed ..... 140 Aug
Computer tracks mortar shells.....180D Feb
Computer, wide-band analog function multiplier ..... 160 Feb
Computers for business..... 122 Jun
Condenser, see Capacitor
Constant-current power supply, regulator for ..... 170D Aug
Contact bounce in relays, measuring.137 Aug
Continuous weather map recorder..196D Jul
Control, see also automatic control
Control circuits, packaging..... 132 Dec
Control, launching, for guided missiles 122 Feb
Control, machine tool..... 178D Oct
Control of magnetic drum speed...140 Aug
Control of a-m and f-m stations by tones ..... 132 Sept
Control system for motors..... 126 Aug
Controlling extrusion of foam plastic on wire, Cambrill..... 144 Apr
Conveyor Belt Production Techniques
Air cylinder pushes pallets..... 238D Feb
Cart simplifies handling of power transformers ..... 246D Jan
Installing mounting clips for i-f transformers ..... 262D Sept
Midget train delivers cabinets to tv assembly line ..... 234D Nov
Oil damper controls wire tension.286D Apr
Pallet turnaround ..... 266D Apr
Paper templates speed start of wiring line ..... 276D Feb
Quick-release clamps pull chassis dollies ..... 230D Nov
Shadowless lighting for tv assembly line ..... 234D Oct
Silicon-steel slitter cuts transformer costs ..... 232D Jul
Three-operator assembly-turntable 222D Nov
Tote rack for i-f strips loads from both sides ..... 226D Nov
TV assembly line uses red trouble lamps ..... 260D Apr
Cork tape cutter..... 244D Sept
Counter, extended range flip-flop....149 Jan
Counter, short-interval timer..... 168 May
Counter, silicon transistor decade....112 Aug
Counter tube batching..... 157 Feb
Countermeasure,- target discriminator 118 Aug
Counting circuit batches components, Tooke ..... 157 Feb
Counting labels with ferroresonant rings, Swarthe & Isborn..... 128 Oct
Coupler, selective, for uhf multiplexer 152 Nov
Criss-cross d-c amplifier, Morrison.198D Aug
Crystal, changing properties of lead sulfide ..... 178D Oct
Crystal filter, staggered..... 166 Dec
Crystal, spectrum analyzer for quartz 160 Oct
Current regulator for van de Graaff magnet, Rogers ..... 151 Oct
Curve plotter, voltage-current..... 156 Dec
Cytoanalyzer compares cancer cells 182D Apr

D

Damping, automatic for tv monitor 230D Mar
Dark-trace tube has infrared erasure 170 Feb
Data processor prepares computer input on ram jets..... 180D Jun
Data reduction system for missile telemetering, McCormick ..... 126 May
Dawn chorus, ionospheric disturbances 198D May

D-C amplifier, criss-cross.....198D Aug
Decade counter employs silicon transistors, Krenitsky .....112 Aug
Decade counter for labels.....128 Oct
Defense-emergency radio van.....214D Oct
Deflection circuit, transistor c-r tube.146 Jul
Delay generator, digital.....148 Dec
Delay-line design (reference sheet), Sodaro .....176 Jun
Delay line subcarrier discriminator, Morgan & Blake.....202 Mar
Demodulator, dynamic diode limiter for f-m .....146 Aug
DEW line radar network in the north spots planes .....184D May
D-layer, plotting static direction...178D Feb
DME, airborne interrogator for.....170 May
Deposited magnetic materials.....210D Jun
Design, cathode compensation for video stages .....156 Nov
Design chart for linear reactor....208 Mar
Design chart, noise factor nomograph 174 Nov
Design chart, power rating of parasitic suppressors .....170 Oct
Design chart, r-f filter.....176 Feb
Design, chassis for experimental work 166 Nov
Design of audio amplifiers.....166 Apr
Design of bias supply for bolometer.208D Oct
Design of chassis for i-f amplifier..182D Aug
Design of delay lines.....176 Jun
Design of i-f transistor transformers.156 Aug
Design of microwave gain-standard horns, Slayton .....150 Jul
Design of notch networks.....172 Sept
Design of overstaggered doublet amplifiers .....158 Jul
Design of transistorized high-gain portable, Sheehan and Ivers.....159 Mar
Design trends in metallic rectifiers..162 Mar
Designing over-horizon communications links, Davidson & Pote.....126 Dec
Designing stable triode microwave oscillators, Stephenson .....184 Mar
Designing 2,000-mc components for communications, Colby .....186D May
Designing ultrasonic alarm systems, Bagno .....106 Aug
Detector-amplifier, infinite impedance 168D Aug
Detector, fire, ionization chamber. 200D Jun
Detector, ice, for aircraft.....142 Dec
Detector, limit .....202D Oct
Detector, null, differential amplifier for 148 Aug
Detector, photoelectric rot, for eggs.140 Jul
Detector, square-law for rms voltages 170 Nov
Detector, ultrasonic burglar and fire.106 Aug
Developments in radioastronomy produce navigation aid.....182D Jan
Diana antenna tracks planets.....166D Aug
Dielectric heating generator, dummy load for .....162D Jul
Dielectric lens for microwaves, Kelleher & Goatley.....142 Aug
Dielectric mixture chart (reference sheet) Sion .....176 Apr
Dielectric transformers for X-band waveguide, Olin .....146 Dec
Differential amplifier for null detection, Barnette & Giacoletto.....148 Aug
Differential gain tests tv color, Schroeder .....114 Aug
Digital computer, see computer
Digital delay generator.....148 Dec
Digital voltage divider using four resistors, Kamm .....176D Dec
Diode, double-based .....198 Mar
Diode limiter, dynamic, for f-m demodulator .....146 Aug
Diode, silicon, using Zener effect in .....182D Dec
Diode, used in time-delay generator 194D Nov
Dip soldering—mechanized production of electronic equipment.....157 Sept
Direct-reading noise-figure indicator, Chase .....161 Nov
Direction finder for small airports..184D Jun
Direction finder, vhf.....168D Jul
Direction finding, vhf, resonant-loop antenna for .....172 Feb
Directional antenna, see antenna
Directly coupled transistor circuits, Beter, Bradley, Brown & Rubinoff.132 Jun
Discriminator, delay line subcarrier.203 Mar
Discriminator, music-speech .....162D Aug
Discriminator, target, for countermeasures .....118 Aug
Distance measurement, airborne interrogator .....170 May
Distribution amplifier for color television .....154 Mar
Diversity reception, ultrasonic switch for .....169 Nov
Divider, digital voltage.....176D Dec
Divider, frequency, four-decade.....154 Apr
Dominion time signals.....182D, 186D Jun
Door opener, radio .....212D Dec
Double base expands diode applications, Suran .....198 Mar
Dual diversity reception, ultrasonic switch for .....169 Nov
Dummy load, paralleled beacon lamps 162D Jul
Dynamic characteristics of triode-connected pentodes, Dessler & Robinson .....208D Dec
Dynamic-diode limiter for f-m demodulators, Mural .....146 Aug
Dynamic receiver selectivity, McLaughlin .....128 Feb
Dynamic spectrum analyzer to study sun .....176D Oct

E

Eddy current plating thickness gage.146 Nov
Egg inspection, photoelectric.....140 Jul
Electric punch speeds insertion of plug-nuts .....234D Jun
Electrocardiograph, see medical electronics
Electrodynamic scales .....152 Jun
Electroluminescence, light amplifier using .....178D Feb
Electromagnet removes nonferrous metals, Lovell .....164 Sept
Electromechanical networks for a-c servo systems, Savant & Savant..190D Feb
Electron microscope exposure timer.206 Mar
Electron paths, tracing.....174 Jun
Electron Tube, see Tube
Electronic chopper for d-c amplifiers 192D Nov
Electronic computers for the businessman, Carroll .....122 Jun
Electronic equipment, mechanized production of .....127 Sept
Electronic filter for high-voltage power supply .....154 Aug
Electronic load .....216D Nov
Electronic organ uses rotating loudspeakers, Markowitz .....116 Jul
Electronic switch eliminates transients, Ludwig & Hind.....163 Oct
Electronic switch for biological observations, Woods .....135 Dec
Electronic switch, music-speech discriminator .....162D Aug
Electronic weighing on the production line, Bell & Ferstle.....152 Jun
Electronics markets for equipment..138 Apr
Electronics, survey of 25 years.....124 Apr
Electrostrictive ceramic relay.....226D Mar
Embedding technique for three-tube plug-in unit, Fox.....250D May
Empire State antenna for WOR-TV, Adams, Alford, Leach, Rubin & Abel 214D Apr
Encapsulation, dielectric mixture chart 176 Apr
Encoding and matrixing color television .....140 Nov
Engine temperature indicator.....129 Nov
Engine, x-ray television shows inside 182D Apr
Envelope-delay measurement, color-video .....144 Jun
Equipment data sheets.....228D Mar
Equipment, markets for electronic..138 Apr
Equipment reliability .....180D Jul
Erasing, infrared, for dark-trace tubes 170 Feb
Etched antenna for supersonic aircraft 130 Jul
Etched wiring band-pass filter.....152 May
Etched wiring—mechanized production of electronic equipment.....138 Sept
Evaporated magnetic materials, Biola 210D Jun
Expanded-scale voltmeter for a-c measurements, Galman .....164 Dec
Experimental light amplifier employs electroluminescence .....178D Feb
Exposure timer for the electron microscope, Bishop .....206 Mar
Extending uhf-tv with booster amplifiers, Epstein, Morrison & Woodward 112 Jul
Extrusion of plastic insulation, control of .....144 Apr
Eye, electromagnet removes nonferrous metal from .....164 Sept

F

Facsimile speeds plant messages...222D Jun
Facsimile speedup enhances usefulness, Hogan .....134 Jul
Fan-pencil antenna for search radars, Trinter .....142 May
Farm machinery parts speeded by radio .....176D Nov
Faster radiosonde .....208D Dec
Feedback clamp circuit for tv, Wendt & Squires .....182D Jul
Feedback-stabilized transistor amplifier, Slaughter .....174 May
Ferrite core memory used in juke box 138 Oct
Ferrite-core memory uses pulse transformers .....194 Mar
Ferrite microwave modulator.....139 May
Ferroresonant rings used in label counter .....128 Oct
Ferrule wrench aids mounting of panel lamps, Ives .....212D Jul
Field strength, see propagation
Filter, bandpass for receiver.....128 Feb
Filter, band-pass, using strip-line...152 May
Filter design, r-f.....176 Feb
Filter, electronic, for high-voltage power supply .....154 Aug
Filter, staggered triple crystal.....166 Dec
Fingertip touch actuates circuit....200D Oct
Fire call box.....198D Oct
Fire detection, ionization chamber.200D Jun
Fire detector, ultrasonic alarm system 106 Aug
Fire watching by remote tv.....178D Oct
Fixed L-C oscillator without taps, Fleming .....216D Mar
Flat cathode-ray tube simplifies cockpit instrumentation .....214D Mar
Flat cathode-ray tubes.....186D Nov
Flight trainer, transistor modulator for 126 Sept
Flip-flop counter has extended range, Beckwith .....149 Jan
Fluorescent lighting, magnetic frequency multiplier for.....224D May
Flush-panel doors serve as tops for engineering desks .....266D Mar
Flying-spot function generator.....149 Jun
F-M antenna inside the a-m tower, Scheidorf & Klink.....130 Aug
F-M demodulator, dynamic diode limiter for .....146 Aug
F-M discriminator, delay line subcarrier .....203 Mar
F-M, multiplexing transmitters.....146 Oct
F-M, phase measurement.....142 Feb
F-M signal generator, transistorized.133 Feb
F-M tuning units using afc.....180D Jun
Fog alarm, microwave controlled...122 Jul
Formica bench-tops reduce rejects.240D May
Forward scatter, designing communication links .....126 Dec
Forward scatter, extend uhf comunications .....122 Oct
Four-decade frequency divider, Jensen & McGeogh .....154 Apr
Frequency divider, four-decade.....154 Apr
Frequency Modulation, see broadcast, communication, f-m, etc
Frequency multiplier, magnetic, for fluorescent lighting .....224D May
Frequency response, improving cathode-follower .....190D Aug
Frequency selective coupler for uhf multiplexer .....152 Nov
Frequency standard, cesium, for atomic clock .....180D Apr
Frequency standard, microwave.....168 Jun
Frequency synthesizer for Navy transmitter .....138 Jan
Frequency tripler in magnetic amplifier .....122 Sept
Function generator, flying-spot.....149 Jun

G

Gage, pressure, for ship models...196D Jan
Gage, pulsed eddy current plating thickness .....146 Nov
Gain-standard horns for microwave 150 Jul
Garage door opener, radio.....212D Dec
Gas discharge tube, see tubes
GCA, portable .....154 Oct
Generating r-f energy for 4-bev betatron, Winningstad .....164 Feb
Generator, signal, see also oscillator
Generator, audio standard.....161 Dec
Generator, millimeter wave produces light .....180D Feb
Generator, nonlinear time delay..194D Nov
Generator, precision digital delay....148 Dec
Generator, pulse-series .....224D Mar
Generator, pulse, transistor.....132 Nov
Generator, repetition rate.....148 Nov
Generator, transistor waveform.....128 Jul
Generator, transistorized f-m signal 133 Feb
Generator, waveform, using pulse technique .....149 Jun
Generator, waveshape, high voltage 222D Apr
Geodimeter determines precise baselines .....194D Jul
Geological survey, cro display for seismic recordings .....160 May
Geophysical exploration speeded by improved magnetometer .....162D Aug
Geophysics, tape recorder for.....152 Jan
Germanium, see transistors
Getting the most from mobile radio, McKenzie .....156 Jun
Goniometer for D-layer study.....178D Feb
Green-rot detector, photoelectric.....140 Jul
Grid-control tube, uhf-tv.....130 Apr

Ground controlled approach radar..154 Oct
Guardian picket ship.....164D Jul
Guided missile, antenna for telemetering .....164 Jun
Guided missile, data reduction system for .....126 May
Guided missile launching control...122 Feb
Guided missile, simulator tests radar .....127 Jul
Gyrator, ferrite microwave modulator .....139 May

H

Head, alloys improve magnetic recording .....137 Jun
Headlight dimmer for automobiles..170 Mar
Helicopter measures antenna pattern Brueckmann .....134 Nov
Holography, spectrum analyzer for sun .....176D Oct
High fidelity, see also audio
High fidelity transistor power amplifier, Riddle .....174D Sept
High-power uhf-tv uses grid-control tube, Koros .....130 Apr
High-quality receiver for tv rebroadcasting, Rosenbert .....153 Dec
High-speed photography, shutter for .....171 Jun
High-voltage supply uses electronic filter, Wouk .....154 Aug
High-voltage waveshape generator, Reed .....222D Apr
Higher velocity of propagation...140D Sept
Highly regulated r-f voltage supply, Sloan, Raible & Testerman...192D Apr
Horn artenna, broadband.....188D Aug
Horn, microwave gain-standard.....150 Jul
House analog .....206D Aug
How accurate are radar speed meters?, Brantley .....132 Dec
How to design i-f transistor transformers (reference sheet), Webster .....156 Aug
How to design overstaggered doublets (reference sheet), Webb.....158 Jul
How to design sailboat antennas, Robberson .....140 Jun
Hysteresis, testing in relays.....202D Dec

I

Ice detector for lighter-than-air craft, Thurston .....142 Dec
I-F amplifier, chassis design for..182D Aug
I-F transformer, design for transistor .....156 Aug
Impedance recorder, complex.....167 Sept
Improving audio quality of mobile radio, Buesing .....190D Oct
Improving cathode-follower frequency response, Woods .....190D Aug
Impulse magnetizer for permanent magnets, Moore .....121 Aug
Indicator, noise figure.....161 Nov
Indicator, temperature, for engine..129 Nov
Induction heating for high purity silicon .....182D Feb
Induction soldering of coaxial tuned stubs .....278D May
Industrial control, phase shifter for .....188 Mar
Industrial electronics markets.....138 Apr
Industrial microwave calibrator, Vogler and Stinehelfer.....168 Jun
Industrial oscillators, reducing shock hazard .....180D Jan
Infinite impedance detector-amplifier, Armstrong .....168D Aug
Infrared spectrophotometer, tape-controlled .....136 Feb
Infrared speeds erasure of dark-trace tubes, Holborn & Hodowanec.....170 Feb
Input, low noise, for preamplifier....147 Feb
Insect control by electron irradiation, Baker, Taboada & Wiant.....202D May
Instrument, see measuring equipment
Instrument, noise figure indicator..161 Nov
Insulation, automatic control of extrusion .....144 Apr
Intense sound bad for tubes.....196D Feb
Intercity consultation uses color television .....216D Mar
Interior Dept. uses underwater tv..218D Oct
Interrogator, airborne .....170 May
Interval timer, short.....168 May
Ion-gage supply protects tubes, Raible and Testerman .....210D Feb
Ionosphere, see also propagation
Ionosphere research, airglow aids..212D Mar
Ionospheric disturbances .....198D May
Ionospheric research, theory of thunderstorm electricity .....134D Apr
Ionization chamber detects fires quickly .....206D Jun
Irradiation, insect control by electron .....202D May

J

Japanese transistor broadcast receiver .....174 Dec
Jig Techniques
Chassis centering guides.....236D Jan
Chassis-holding fixture .....254D Jan
Chassis-holding fixture .....264D Jun
Handball in clamp holds subassemblies .....222D Jan
Jack-wiring jig .....290D Apr
Magnetic holding tool makes parts serve as drilling gage.....222D Nov
Metal jig aids assembly of coaxial tuning units .....238D Jul
Prop on pallet supports chassis at angle .....288D Apr
Wood jigs speed mounting of large parts .....252D Apr
Terminal plug holder.....236D Nov
Juke box uses ferrite-core memory, Schultz & Boesen.....138 Oct
Junction transistor, see also transistor
Junction transistor switching circuits, Prugh .....168 Jan

K

Kerr-cell shutter has submicrosecond speeds, Nicholson and Ross.....171 Jun
Klystron, see also tube
Klystron, modulated .....186D Jan
Klystron, tunable X-band.....136 Jan

L

Labeling Techniques
Numbered clips simplify replacement of parts.....228D Aug
Overhead conveyor for tv uses color-coded carriers .....212D Aug
Press-driven turntable aids printing of selenium rectifiers.....232D Jul
Punching chassis stencils on Addressograph .....242D Feb
Red flag on clip serves as parts-needed signal .....248D Feb
Shop-made rubber stamps identify chassis parts .....254D Apr
Tape printer aids identification of antenna parts .....236D Apr
Yellow alligator clips identify terminals .....292D Apr
Launching control for guided missiles, Schrock .....122 Feb
Lens for microwave, dielectric .....142 Aug
Letters printed by c-r tube.....182D May
Light amplifier uses electroluminescence .....178D Feb
Light beam controls tv receiver...204D Dec
Light control for automobiles.....170 Mar
Light hydraulic presses cut phono pickup costs, Holmes.....250D Jan
Light produced by millimeter wave generator .....180D Feb
Light, traffic, controlled by radio....194 Jun
Lighting, magnetic frequency multiplier for fluorescent.....224D May
Limit detector, sensitive.....202D Oct
Limiter, see also f-m
Limiter, dynamic, for f-m demodulator .....146 Aug
Linear accelerator, r-f power supply .....164 Feb
Linear accelerator, spectrometer regulator for r-f.....137 Nov
Linear power amplifier for sub transmitters, Bruene .....124 Aug
Linear reactor chart (reference sheet), Lee .....208 Mar
Linearity and phase nomograph.....178 Apr
Linearity, measurement, sawtooth .....204D Nov
Linearity, video, by cathode compensation .....136 Nov
Loading, potentiometer design for, minimal .....144D Feb
Lobotomy, ultrasonics as a substitute for .....164D Jul
Local oscillator for c-w radars, Goldberg .....166 May
Logarithmic amplifier, target discriminator .....118 Aug
Long-distance waveguide may rival coaxial cables .....212D Mar
Long-wave transmitter, Navy.....138 Jan
Loop antenna for vhf direction finding .....172 Feb
Loudspeakers, electronic organs using rotating .....116 Jul
Low-distortion audio oscillator.....158 May
Low-frequency oscillator .....144 Oct
Low-frequency sound reducer.....188D Jun
Low-impedance capacitive transducer .....161 Jun
Low-noise input stage for audio preamplifier, Noble & Hilliard.....147 Feb
Low-ripple adjustable regulated power supply, Hetland & Buss.....164 Nov

M

Machine assembly—mechanized production of electronic equipment..147 Sept
Magnet, impulse magnetizer for permanent .....131 Aug
Magnetron Production Techniques
Controlling dust in microwave tube assembly plant, Leng.....238D Apr
Magnetic amplifier, audio.....122 Sept
Magnetic amplifier, autopilot servo .....208D May
Magnetic drum, synchronizing.....140 Aug
Magnetic frequency multiplier for fluorescent lighting, Downie.....224D May
Magnetic materials, evaporated.....210D Jun
Magnetic recording, alloys improve..137 Jun
Magnetic tape, see also record, tape recording
Magnetic tape controlled chemical analysis .....136 Feb
Magnetic tape improves geophysical recordings, Begun .....153 Jan
Magnetizer, impulse for permanent magnets .....131 Aug
Magnetometer for geophysical exploration .....162D Aug
Magnetron, see tube
Marine communications, design of boat antennas .....140 Jun
Market for electronic equipment, Milek .....128 Apr
Master control, WOR.....204D Sept
Materials, evaporated magnetic....210D Jun
Materials for relays.....144 Jan
Matrix, ferrite-core memory.....194 Mar
Matrix, ferrite core memory used in juke box .....138 Oct
Matrixing and encoding color for telecasting, Taub, Rabinowitz, Schacher & Star .....140 Nov
Measurement, micrometer sorter....156 May
Measurement, phase meter for water velocity .....128 Sept
Measurement, sawtooth linearity..204D Nov
Measuring equipment, antenna for vhf direction finding .....172 Feb
Measuring equipment, audio standard generator .....161 Dec
Measuring equipment, color-burst deviation meter .....149 May
Measuring equipment, color-video envelope delay .....144 Jun
Measuring equipment, differential amplifier for null detector.....148 Aug
Measuring equipment, differential gain test for color tv.....114 Aug
Measuring equipment, expanded-scale voltmeter .....164 Dec
Measuring equipment, goniometer for D-layer study .....178D Feb
Measuring equipment, phase angle comparator .....188D Jan
Measuring equipment, phase meter for color tv .....156 Jan
Measuring equipment, phase meter for color tv and f-m.....142 Feb

Measuring equipment, photometer for reflecting road signs....204D Feb
Measuring equipment, relay contact bounce ....137 Aug
Measuring equipment, sawtooth pulser gives voltage current curves....156 Dec
Measuring equipment, servo analyzer 172 Apr
Measuring equipment, spectrum analyzer for mobile radio....180D Feb
Measuring equipment, transistorized f-m signal generator....133 Feb
Measuring equipment, transmission test set ....145 Dec
Mechanized production of electronic equipment, Markus ....137 Sept
Mechanized production, punch-card control ....127 Nov
Medical electronics, blood pressure recorder ....178D Jun
Medical electronics, cytoanalyzer for cancer cells ....182D Apr
Medical electronics, electromagnet removes nonferrous metals from eye 164 Sept
Medical electronics, electronic switch for ....163 Oct
Medical electronics, electronic switch for biological observation ....135 Dec
Medical electronics, exposure timer for electron microscope ....206 Mar
Medical electronics, physiological monitor for anesthesia....130 Oct
Medical electronics, ultrasonic cancer diagnosis ....174 Mar
Medical electronics, ultrasonics as substitute for lobotomy....164D Jul
Memory, ferrite-core ....194 Mar
Memory, ferrite-core used in juke box 138 Oct
Memotron storage tube....161 Jan
Metal, nonferrous, removed from eye 164 Sept
Metallic rectifiers approach infinite life, Rockett ....162 Mar
Meteorology, radar aids....182D Sept
Meteorology, rain gage sends radio report ....186D Sept
Meteorology, weather mapping radar 178D Sept
Meter, phase, for color tv....156 Jan
Meter shows color-burst deviation, Joffe ....149 May
Micrometer, automatic, sorts insulating wafers ....156 May
Microphone nomograph (reference sheet), Conover ....172 Oct
Microphonics in transistors....206D Sept
Microscope, exposure timer for electron 206 Mar
Microwave, band-pass filter using strip-line ....152 May
Microwave, broadband horn antenna 188D Aug
Microwave calibrator, industrial....148 Jun
Microwave, dielectric transformer for X-band ....146 Dec
Microwave, extended range transmission ....182D May
Microwave gain-standard horns....150 Jul
Microwave lens, dielectric....142 Aug
Microwave, long distance waveguide 212D Mar
Microwave, millimeter wave generator produces light....180D Feb
Microwave, modulated klystron....186D Jan
Microwave modulator uses ferrite gyrator, Barry and Clarke....139 May
Microwave, noise figure indicator....161 Nov
Microwave, nomograph for rectangular waveguides ....172 Jan
Microwave oscillator, designing stable triode ....184 Mar
Microwave, reflection-type asymmetrical ....192D Dec
Microwave, rural telephone....206D Jan
Microwave system controls fog alarm, Park ....122 Jul
Microwave, tunable X-band cavity..155 Jan
Microwave, X-band amplifier....202D Apr
Military electronics, antenna for aircraft carrier ....174D Dec
Military electronics, antenna for missile telemetering ....164 Jun
Military electronics, data reduction for missile telemetering ....126 May
Military electronics, equipment reliability ....180D Jul
Military electronics, fan-pencil radar antenna ....142 May
Military electronics, launching control for guided missiles....122 Feb
Military electronics markets....185 Apr
Military electronics, models reveal how to avoid Radar ....122 Jan
Military electronics, multicolor radar for navy ....254D Mar
Military electronics, navy transmitter uses frequency synthesizer....138 Jan
Military electronics, pack set using helmet antenna ....150 Mar
Military electronics, radar and computer track mortar shells....180D Feb
Military electronics, simulator tests missile radar ....127 Jul
Military electronics, sonar target simulator ....167 Mar
Military electronics, target discriminator for countermeasures....118 Aug
Military electronics, telephone channels increased ....180D Apr
Military electronics, testing airborne components ....181 Mar
Millimeter wave generator produces visible light ....180D Feb
Mobile direction finder, antenna for..172 Feb
Mobile power supply for 6 and 12 volts, Backman ....216D May
Mobile radio, compensated squelch for 142 Jul
Mobile radio, improving....156 Jun
Mobile radio, improving audio....190D Oct
Mobile radio, single tone calling....144 May
Mobile radio, spectrum analyzer measures ....180D Feb
Models for avoiding radar....122 Jan
Modern fifty-kilowatt broadcast transmitter, Witty ....168 Mar
Modular simulator tests missile radar, Krakauer and Bibbero....127 Jul
Modulated klystron ....186D Jan
Modulator, ferrite microwave....139 May
Modulator, series-tube ....158 Nov
Modulator, transistor, for flight trainer 126 Sept
Monitor for anesthesia....130 Oct
Monitor, tv receiver used as....131 May
Moon tracking antenna....166D Aug
Mortar shells tracked by radar and computer ....180D Feb
Motor control, variable speed....162 Apr
Motor speed control ....126 Aug
Multichannel oscillator, phase controlled ....164 Apr
Multiple waveform generator, transistor ....138 Jul
Multiplexer, uhf, uses selective couplers ....152 Nov
Multiplexing f-m broadcast transmitters, Bose ....146 Oct
Multiplier, wide-band analog....160 Feb
Multivibrator, junction transistor...168 Jan
Music, electronic organ with rotating loudspeaker ....116 Jul
Music, electronic synthesizer....200D Apr
Music-speech discriminator ....162D Aug
Muting circuit for mobile radio ....143 Jul

N

Navigating by carrier-based TACAN beacons ....178D Jun
Navigation, adf for small airport..184D Jun
Navigation, airborne interrogator for DME ....170 May
Navigation, computer-controlled fin 212D Nov
Navigation, microwave controlled fog alarm ....122 Jul
Navigation, TACAN system....174D Oct
Navy transmitter uses frequency synthesizer, Romander & Watson....138 Jan
Negative resistance diode, double based 198 Mar
Network, design of notch....172 Sept
Network, electromechanical for a-c systems ....190D Feb
New ferrite-core memory uses pulse transformers, Papian ....194 Mar
New government patents....190D Feb
New relay materials improve performance, Rockett ....144 Jan
New transmission techniques extend range sevenfold ....182D May
Night airglow aids ionosphere research 212D Mar
Nipkow disk, use in headlight dimmer 170 Mar
Noise factor nomograph (reference sheet), McCarrell ....174 Nov
Noise figure, indicator, direct reading 161 Nov
Noise testing for electronic components ....181 Mar
Nomograph, microphone ....172 Oct
Nomograph, noise factor....174 Nov
Nomograph, phase-linearity ....178 Apr
Nomographs for rectangular waveguides (reference sheet), Chen....172 Jan
Nonferrous metal removed from eye 164 Sept
Nonlinear time-delay generator uses diodes ....194D Nov
Notch network design (reference sheet), Savant & Savant....172 Sept
Nuclear magnetic resonance magnetometer ....162D Aug
Nuclear research, current regulator for van de Graaff generator....161 Oct
Nuclear research, r-f power supply for bevatron ....164 Feb
Nuclear research, spectrometer regulator stabilizes r-f....137 Nov
Null detector, differential amplifier for 148 Aug
Nut starters, Ives....236D Jul

O

Observing whistlers ....193D May
Oil prospecting, cro display for seismic recordings ....160 May
One-hand vacuum lift moves tv tubes safely ....320D Mar
One-man tv camera aligner, Shepard 214D Dec
Optical images superimposed on radar oscilloscope ....214D Mar
Optics of dielectric microwave lens 142 Aug
Organ, electronic, using rotating loudspeakers ....116 Jul
Oscillator, audio, low-distortion....158 May
Oscillator, blocking, transistor....168 Jan
Oscillator, Colpitts, failure to oscillate ....184D May
Oscillator, L-C, without taps....216D Mar
Oscillator, local, for c-w radar....166 May
Oscillator, phase controlled multichannel ....164 Apr
Oscillator, reducing shock hazard of industrial ....180D Jan
Oscillator, stable triode microwave..134 Mar
Oscillator, subaudio ....144 Oct
Oscillator, subharmonic crystal....206D Jan
Oscillator, transistor multiwaveform 138 Jul
Oscillator, tunable cavity X-band..135 Jan
Oscillator, two-terminal push-pull..202D Aug
Oscillogram, trigger adapter for transient ....159 Apr
Over-horizon propagation, see also forward scatter, propagation
Over-horizon radio to link islands..172D Dec
Overseas radiotelephone service links most of world's telephones....164D Jul
Overstaggered doublet amplifier design 158 Jul

P

Pack set using helmet antenna....150 Mar
Packaging of control circuits....122 Dec
Packaging Techniques
Carton turnover machine....266D Feb
Styrofoam serves as shipping block 246D Jan
Pads, see attenuators
Panel, video patch....210D Apr
PAR, portable ....154 Oct
Paralleled beacon lamps serve as dummy load ....162D Jul
Parasitic suppressors, power rating..170 Oct
Patch panel, video....210D Apr
Patents, new government....190D Feb
Path, tracing electron....174 Jun
Pattern, helicopter measures antenna 134 Nov
Pentode, triode-connected, dynamic characteristic ....208D Dec
Permalloy recording heads....137 Ju
Permanent magnet, impulse magnetizer for ....121 Aug
Pertinent patents, see also patents
Pertinent Patents, Chaffin....210D Jan
222D Feb, 256D Mar, 226D Apr
198D Jul, 206D Sept
Phantastron repetition rate generator 148 Nov
Phase-Controlled Multichannel Oscillator, Hahnel ....164 Apr
Phase-linearity nomograph (reference sheet), Sodaro ....178 Apr
Phase meter analyzes color tv systems, Houghton ....156 Jan
Phase meter, comparison....188D Jan
Phase meter, complex impedance recorder ....167 Sept
Phase meter measures water velocity 128 Sept
Phase measurement for color tv and f-m, Schlesinger ....142 Feb
Phase shift measurement in color-video ....144 Jun
Phase shift nomograph....178 Apr
Phase shifter for industrial control 188 Mar
Phonograph pick-up, capacitive transducer ....161 Jun
Photocell label counter....128 Oct
Photoelectric control for television receiver ....204D Dec
Photoelectric inspector detects green rot in eggs, Norris....140 Jul
Photoelectric reader feeds business machines, Shepard and Heasly....134 May
Photoetched antennas for supersonic aircraft, Sommers ....130 Jul
Photograph transmission by facsimile speeded up ....134 Jul

Photography, submicrosecond shutter 171 Jun
Photometer for ionosphere research 212D Mar
Photometer tests reflecting road signs, Giovanelli .....204D Feb
Photometer timer for electron microscope .....206 Mar
Physiological monitor for anesthesia, Gilford & Broida.....130 Oct
Picket ship .....164D Jul
Picture Tube Techniques
Mounting picture tube in color tv cabinet .....246D Dec
Piercing with squeeze riveter.....230D Aug
Plastic, dielectric mixture chart....176 Apr
Plastic insulation, controlling extrusion of .....144 Apr
Plating thickness gage, eddy current 146 Nov
Plug-in rectifier replaces tube.....198D Aug
Pogo parachute replaces drones as missile target .....180D Jan
Portable analyzer measures mobiles 180D Feb
Portable precision approach radar, Levin .....164 Oct
Potentiometer design for minimal loading, Coleman .....184D Feb
Potting, dielectric mixture chart....176 Apr
Power amplifier, linear, for sab....124 Aug
Power amplifier, transistor.....174D Sept
Power rating of parasitic suppressors (reference sheet), Huis.....170 Oct
Power rectifier, silicon for a-c line operation .....146 Apr
Power supply, high-voltage, using electronic filter .....154 Aug
Power supply, highly-regulated r-f..192D Apr
Power supply, ion-gage.....210D Feb
Power supply, low ripple regulated..164 Nov
Power supply, mobile, for 6 and 12 volts .....216D May
Power supply, regulator for constant-current .....170D Aug
Power supply, r-f, spectrometer regulated .....137 Nov
Power supply, using silicon power rectifiers .....146 Apr
Power supply, vibrating ignitor tube for .....248D Mar
Preamplifier, see also amplifier
Preamplifier, low-noise input stage..147 Feb
Precise measurement of sawtooth linearity .....204D Nov
Precision approach radar, portable..154 Oct
Precision digital delay generator, Perzley .....148 Dec
Precision time-delay .....218D Nov
Preferred circuits standardization.182D Nov
Preparing high-purity silicon by induction heating .....182D Feb
Pressure gage for ship-model hulls, Christensen & Funder.....196D Jan
Precision calibrator checks radar beacons, Sinish .....150 Apr
Printed Circuit Techniques
Controlling sludge in etched wiring bath .....238D Nov
Dip-soldering clamp masks tube socket .....242D Dec
Grounding wiring boards.....256D Dec
Modular bundles use etched-wiring boards, Roman .....230D Dec
Plug-in assemblies use standard component bodies .....218D Dec
Production of curved etched-wiring boards .....262D Dec
Quality control charts for printed wiring, Heywood .....216D Jul
Router cuts curves in wiring boards 224D Dec
Specifications for printed-wiring production .....266D May
Stencilled symbols aid assembly on etched wiring boards.....224D Oct
Substitutes for eyelets in etched wiring, Martin & Vavra.....250D Dec
Test pattern checks printed-circuit panels .....224D Jan
Tool spreads lugs of socket on etched-wiring board .....220D Sept
Printed film transparencies reduce drafting time .....246D Sept
Printing, transducer tube changes signals to letters.....182D May
Private flying, TACAN.....174D Jul
Process control, see automatic control
Process control, packaging circuits..122 Dec
Producing oscillations with a Colpitts circuit, McCusker .....184D May
Production, automatic assembly with punch card control.....122 Nov
Production control, see also automatic control
Production control, capacitor sorting.106 Jul
Production control, electronic weighing 152 Jun
Production control, micrometer sorter 156 May
Production, mechanized, for electronic equipment .....137 Sept
Production Techniques, see type; capacitor; coil; magnetron; printed circuit; etc.
Production testing of audio amplifier, oscillator for .....158 May
Programming, automatic .....135 Oct
Propagation, airborne laboratory..164D Aug
Propagation, designing communication links .....126 Dec
Propagation, forward scatter in uhf..122 Oct
Propagation, higher velocity.....180D Sept
Propagation in rectangular waveguides 172 Jan
Propagation pattern measured by helicopter .....134 Nov
Propagation, plotting D-layer static direction .....178D Feb
Properties of lead sulfide crystals changed .....178D Oct
Psychoacoustic research, electronic switch for .....162 Oct
Pulse amplifier .....155 Jul
Pulse amplifier .....170 Sept
Pulse amplifier, cathode compensation 156 Nov
Pulse-cross display for tv alignment 184D Apr
Pulse Generator, see also Generator
Pulse generator, high voltage....222D Apr
Pulse generator, transistor.....132 Nov
Pulse magnetizer for permanent magnets .....121 Aug
Pulse-series generator, Grisamore & Uyehara .....224D Mar
Pulse techniques used in waveform generator .....149 Jun
Pulse transformers used in ferrite core memory .....194 Mar
Pulsed eddy currents gage plating thickness, Waidelich .....146 Nov
Pulsed tones control a-m and f-m stations, Michels .....132 Sept
Pump feeds cement to both sides of mold .....254D Sept
Punched cards control job-lot assembly system, Gamble, Godwin & Feldheim 122 Nov
Punched slots in back cover anchor built-in tv antenna.....220D Sept
Push-pull oscillator, two-terminal..202D Aug

Q

Quartz, crystal, spectrum analyzer..160 Oct

R

Radar, AEW planes keep watch...178D Nov
Radar aids meteorology.....182D Sept
Radar and computer track mortar shells back to source.....180D Feb
Radar cane guides sightless.....208D Jun
Radar, C-band weather mapping..178D Dec
Radar, DEW line.....184D May
Radar, fan-pencil antenna.....142 May
Radar, portable precision approach.154 Oct
Radar, infrared erasure for dark-trace tubes .....170 Feb
Radar, local oscillator for c-w.....166 May
Radar, missile, checked by simulator 127 Jul
Radar, models show how to avoid..122 Jan
Radar, nomographs for rectangular waveguides .....172 Jan
Radar raovie .....198D Dec
Radar, optical image superimposed on 214D Mar
Radar range calibrator checks beacons 150 Apr
Radar ship .....164D Jul
Radar, short-interval timer for testing 168 May
Radar speed meters, accuracy of.....132 Dec
Radar, tunable X-band cavity.....135 Jan
Radiation, see also propagation
Radiation pattern measured by helicopter .....134 Nov
Radio, see also communications, broadcast
Radio astronomy as navigation aid.182D Jan
Radio astronomy, spectrum analyzer for sun .....176D Oct
Radio astronomy, spider antenna...180D Jun
Radio, audience survey.....126 Jan
Radio circuit transmits statistical data from North Africa.....184D Jan
Radio control gives right-of-way..194D Jun
Radio, dynamic receiver selectivity..128 Feb
Radio, fifty-kw broadcast transmitter 168 Mar
Radio, improving mobile.....156 Jun
Radio opens garage door.....212D Dec
Radio receiver afc for f-m tuning..180D Jun
Radio, single-tone calling for mobile 144 May
Radiosonde, faster .....208D Dec
Rain gages send radio reports....186D Sept
Reactance voltage bias source, Burris 218D Feb
Reactor, linear, design chart.....208 Mar
Reader, photoelectric .....134 May
Rebroadcasting, high quality tv receiver for .....152 Dec
Rebroadcasting uhf .....131 May
Receivers, see also f-m, television
Receiver, design of transistorized portable .....159 Mar
Receiver, improving audio in mobile 190D Oct
Receiver, Japanese transistor.....174D Dec
Receiver selectivity, dynamic.....128 Feb
Receiver, squelch for mobile.....148 Jul
Receiver, tv, alignment by pulse-cross display .....184D Apr
Receiver, tv, for rebroadcast.....152 Dec
Receiver, tv, light beam controls..204D Dec
Receiver, tv, used as rebroadcast monitor .....131 May
Receiver uses afc for f-m tuning...180D Jun
Receiver, wide-band amplifier for uhf 158 Dec
Recorded broadcast, automatic.....135 Oct
Recorder, 14-channel tape, for geophysical .....152 Jan
Recorder, blood pressure.....178D Jun
Recorder, complex impedance.....167 Sept
Recording, alloys improve magnetic.137 Jun
Recording and tabulating the radio-tv audience, Brown.....126 Jan
Recording, seismic, cro display.....160 May
Rectifier, plug-in, replaces tube.....198D Aug
Rectifier, power, for a-c line operation 146 Apr
Rectifier, trends in metallic.....162 Mar
Rectifier, vibrating ignitor.....248D Mar
Reducing hazard of electrical shock in industrial oscillators .....180D Jan
Reference sheet, design of i-f transistor transformers .....156 Aug
Reference sheet, dielectric mixture chart .....176 Apr
Reference sheet, linear reactor chart 208 Mar
Reference sheet, microphone nomograph .....172 Oct
Reference sheet, noise factor nomograph .....174 Nov
Reference sheet, notch network design 172 Sept
Reference sheet, overstaggered doublets .....158 Jul
Reference sheet, power rating of parasitic suppressors .....170 Oct
Reference sheet, r-f filter design...176 Feb
Reference sheet, rectangular waveguide .....172 Jan
Reference sheet, standard electronics symbols .....176 May
Reference sheet, tracing electron paths 174 Jun
Refinery, automatic control of.....130 Jan
Reflection from automobiles in vhf-tv .....166D Jul
Reflection-type asymmetrical waveguide, Ishii .....192D Dec
Reflectometer for road signs.....204D Feb
Reflector, see also antenna
Regulated r-f power supply.....192D Apr
Regulation, low ripple power supply.164 Nov
Regulator, current, for van de Graaff generator .....151 Oct
Regulator for constant current power supplies, Deichert .....170D Aug
Regulator, motor speed.....126 Aug
Regulator, spectrometer, stablizes r-f 137 Nov
Relay contact bounce measurements, Jiu .....137 Aug
Relay design trends.....144 Jan
Relay, electrostrictive ceramic....226D Mar
Relay, microwave, for rural telephone 208D Jan
Relay, sensitive thyratron.....172D Dec
Relay, zero hysteresis.....202D Dec
Relays, special purpose.....150 Feb
Reliability, equipment .....180D Jul
Remote control, see also Telemetering
Remote control for refinery operations 130 Jan
Remote tv camera spots forest fires.178D Oct
Repeater amplifies in either line direction, Merrill, Smethhurst & Rose..184 Jan
Repeater, transoceanic telephone..178D Sept
Repetition-rate generator has high accuracy, Plemenos .....148 Nov
Resistor, power rating parasitic suppressors .....170 Oct
Resistor Production Techniques
Assembly fixture for ganged precision potentiometers .....222D Oct
Assembly fixtures for precision potentiometers .....230D Mar
Automatic riveter makes resistor terminal boards .....246D Mar
Capping resistors .....240D Oct
Coil-winder for precision potentiometers .....248D Apr
Cutting and flattening helices for potentiometers .....246D Oct
Cutting tapered cards for precision potentiometers .....266D Nov
High-speed color bander.....262D Feb
Hopper-fed automatic lead cutter for carbon resistors.....222D Sept
Lacer-insert packaging for boron-carbon resistors .....264D Sept
Life-testers for precision potentiometers .....226D Jul
Packaging resistors for automatic unloading .....254D Oct
Potting with hypo syringe.....228D Jan
Resistor lead cutter.....260D Nov
Resistor-spiraling machine is completely automatic .....222D Oct
Resistor-varnishing setup .....252D Oct

Shock-testing machine for precision potentiometers .....258D Apr
Silvering ends of resistors with conveyorized painting setup.....220D Oct
Sorting silvered resistors.....222D Oct
Welding tape of precision windings 238D Sept
Resonant-loop antenna for vhf direction finding, Eakin.....172 Feb
Response, frequency, improving cathode-follower .....190D Aug
Response of transistor amplifiers..196D Feb
Reverse tv program pickup.....176D Jul
R-F amplifier for uhf-tv.....113 Jul
R-F connectors used in video patch panel .....210D Apr
R-F filter design (reference sheet), Longo & Wolf.....176 Feb
R-F power supply for bevatron.....164 Feb
R-F power supply, highly regulated 192D Apr
Road signs tested by photometer..204D Feb
Robot guidance system for pilotless aircraft .....162D Jul
Robot sings new tunes.....200D Apr
Rubber band protects panel finish during assembly on bench.....231D May
Rural microwave .....208D Jan

S

Saturable reactors, see reactors magnetic amplifiers; etc.
Sawmill, uses closed circuit tv.....214D Mar
Sawtooth linearity measurement...204D Nov
Sawtooth pulser gives voltage-current curves, Sclar & McFolin.....156 Dec
Scaler, see counter
Scanner compares cancer cells against normal cells .....182D Apr
Scanning disk improves auto headlight dimmer, Rabinow .....176 Mar
Scatter propagation, island radio link 172D Dec
Schematic symbols for electronics...176 May
Scientific electronics markets.....138 Apr
Screwdriver Production Techniques
Automatic screw feeder for power screwdrivers .....236D Oct
Magnet controls torque in new air screwdriver .....242D Oct
Seismic recording, cro display.....160 May
Selective calling, improving mobile radio .....156 Jun
Selective calling, mobile radio.....144 May
Selective coupler for uhf multiplexer 152 Nov
Selenium Rectifier Production Techniques
Applying selenium to rectifier cells 242D Jun
Assembling cartridge-type selenium rectifiers .....232D Jun
Automatic electroplater for selenium rectifier sheets .....240D Jun
Automatic turntable tests selenium cells for h-v breakdown.....210D Jul
Draining setup for dipped rectifier stacks .....246D Jun
Silk-screen machine places insulating paint on selenium rectifiers...224D Jun
Spraying counterelectrodes on selenium rectifier plates.....210D Jul
Vacuum metallizing of selenium rectifiers .....258D Nov
Semiconductor, see diode, transistor, etc.
Sensitive limit detector, Porter....202D Oct
Sensitive thyratron relay operates on microampere, Hartis .....172D Dec
Series-tube modulates amplifier screen-grid, Bernard .....158 Nov
Servo amplifier, autopilot magnetic 208D May
Servo analyzer for wide-range testing, Dickey .....172 Apr
Servo control of magnetic drum speed 140 Aug
Servo system, electromechanical network .....190D Feb
Shielded room, air conditioned.....180D Dec
Shock hazard in industrial oscillators 180D Jan
Short-interval timer, Moerman.....168 May
Shutter, submicrosecond Kerr-cell..171 Jun
Signal generator, see also generator, oscillator
Signal generator, audio standard....161 Dec
Signal generator, high voltage.... 222D Apr
Signal generator, transistorized f-m.133 Feb
Silicon diode, using Zener effect in..182D Dec
Silicon power rectifier .....184D Sept
Silicon Power rectifiers for a-c line operation, Rudenberg .....146 Apr
Silicon prepared by induction heating 182D Feb
Silicon transistor, see also transistors
Silicon transistor used in counter...112 Aug
Simple color computer gives trimtimulus values, Burr & White.....166 Oct
Simulator, sonar target.....167 Mar
Simulator tests missile radar.....127 Jul
Single-sideband transmitter, linear power amplifier for.....124 Aug
Single-tone calling simplifies mobile radio, Hassel .....144 May
Single-tube capacitance transducer circuit, Fleming .....182D Oct
Slot-array antenna, photoetched....130 Jul
Small airport adf.....184D Jun
Solar battery efficiency doubled in year 182D Jun
Solar battery powers telephone carrier 178D Nov
Solar research, spectrum analyzer for sun .....176D Oct
Soldering Techniques
Automatic soldering gun uses electronic timing .....274D Apr
Double-dip soldering uses chassis vibrator, Cass .....226D Dec
Jaws on pliers bend pigtail leads.260D Feb
Masking and fluxing for dip-soldering .....228D Sept
Radio is dip-soldered with tubes in sockets .....236D Sept
Ultrasonic soldering tools.....246D May
Wishbone-shaped soldering staples save space on panels.....232D May
Solid state, see diodes, transistors, etc.
Sonar target simulator, Cologne & Marriner .....167 Mar
Sorting and weighing on production line .....152 Jun
Sorting, automatic micrometer for..156 May
Sound, see also audio
Sound, effect of intensity on tubes..196D Feb
Sound level, microphone nomograph.172 Oct
Sound reducer, i-f.....188D Jun
Sound reproduction, design factors for audio amplifier .....166 Apr
Special-purpose relays gain new uses, Rockett .....150 Feb
Spectrometer regulator stabilizes r-f, Donner .....127 Nov
Spectrum analyzer for quartz crystals, McDuffie .....160 Oct
Speech-music discriminator .....162D Aug
Speed control for motor.....126 Aug
Speed control, variable, for motors..162 Apr
Speed meters, radar.....132 Dec
Speed of propagation, higher.....180D Sept
Spectrophotometer, tape-controlled..136 Feb
Spectrum analyzer for mobile radio 180D Feb
Spider antenna can beam signals in six directions .....180D Jun
Square-law circuit, Lion & Davis..192D Sept
Square-law detector for rms voltages, Sauber .....170 Nov
Square-law multiplier, diode bridge.167 Sept
Squelch circuit, compensated, for mobile radio .....143 Jul
Squirrel-cage motor speed control system, Spencer .....126 Aug
SSB, see single-sideband
Stabilization, of r-f for spectrometer.127 Nov
Stabilization of transistor amplifier by feedback .....174 May
Stabilizer for ships, computer controlled .....212D Nov
Staggered triple-crystal filter, Hildreth .....166 Dec
Stagger-tuned amplifier design.....158 Jul
Standard, gain, microwave horn....150 Jul
Standard symbols for electronics (reference sheet) .....176 May
Standards, preferred circuit.....182D Nov
Static electricity, formation in thunderstorms .....184D Apr
Station operation, automatic broadcast 135 Oct
Statistics transmitted by radio....184D Jan
Storage tube employs secondary emission, Uhlmann .....161 Jan
Strip-line, band-pass filter using....152 May
Studio amplifier design for color television, Schroeder .....154 Mar
Subaudio oscillator tunes 0-50 cycles, Fleming & Follin.....144 Oct
Subcarrier discriminator, delay line.203 Mar
Subharmonic crystal oscillator.....206D Jan
Supersonic, see ultrasonic
Suppressor, power rating parasitic...170 Oct
Surgery, anesthesia monitor for.....130 Oct
Survey of 25 years of electronics...124 Apr
Survey of 33 computers for business.122 Jun
Surveying, geodimeter determines baselines .....194D Jul
Swish, ionospheric disturbances...198D May
Switch, electronic, eliminates transients .....162 Oct
Switch, electronic, for biology.....135 Dec
Switch, touch-operated .....200D Oct
Switch, ultrasonic, for diversity reception .....169 Nov
Switching circuit, double base diode.198 Mar
Switching circuits, transistor.....168 Jan
Symbols, standard electronic.....176 May
Synchronizing magnetic drum storage speed, Bivans .....140 Aug
Synthesizer, electronic music.....200D Apr
Synthetic quartz commercially available .....212D Oct

T

Table model receiver uses afc for f-m tuning .....180D Jun
TACAN, carrier-based .....178D Jun
TACAN for private planes.....174D Jul
TACAN navigation system shows bearing and distance.....174D Oct
Tank capacitor energy storage....216D Oct
Tape-controlled servos speed chemical analysis, Donnor .....136 Feb
Tape-covered clips serve as clamps.252D Feb
Tape recorder, geophysical.....152 Jan
Tape recording, alloy heads improve.137 Jun
Target discriminator for countermeasures, Weiss & Sixbey.....118 Aug
Target for missiles, parachute.....180D Jan
Target simulator, sonar.....167 Mar
Telemetering, antenna system for missile .....164 Jun
Telemetering, data reduction system for missile .....126 May
Telemetering for broadcast station..132 Sept
Telephone, all-electronic, using storage tube .....161 Jan
Telephone carrier, powered by solar battery .....178D Nov
Telephone, military channels increased 180D Apr
Telephone repeater, transoceanic..178D Sept
Telephone, rural microwave.....208D Jan
Telephone, two-way repeater amplifier 164 Jan
Telephotograph, facsimile speedup..134 Jul
Television, Albion tries commercial 180D Nov
Television, aligning by pulse-cross display .....184D Apr
Television, antenna for WOR-TV..214D Apr
Television, audience survey.....126 Jan
Television, automatic damping improves monitor .....230D Mar
Television, automobile reflection....166D Jul
Television, British color.....206D Sept
Television, British tower.....188D Nov
Television, color-burst meter.....149 May
Television, color, colorimeter for...138 Dec
Television, color, differential gain test 114 Aug
Television, color, phase meter.....156 Jan
Television, color, used for intercity consultation .....261D Mar
Television, color-video envelope-delay measurement .....144 Jun
Television, feedback clamp circuit'182D Jul
Television, flat cathode-ray tube..214D Mar
Television, flying-spot color.....176D Jul
Television, high-power grid-control tube for uhf.....130 Apr
Television, high-speed facsimile for news photos .....134 Jul
Television, Interior Dept. uses underwater .....218D Oct
Television, light beam controls receiver 204D Dec
Television, matrixing and encoding color .....140 Nov
Television, one-man camera alignment 214D Dec
Television, receiver for.....152 Dec
Television, remote, spots forest fires 178D Oct
Television, transistor deflection circuit 146 Jul
Television, uhf, amplifier tube for..176D Nov
Television, uhf rebroadcasting.....131 May
Television, underwater camera....174D Sept
Television, used in sawmill.....214D Mar
Television, wide-band amplifier for uhf 158 Dec
Television, X-ray, shows inside of engine .....182D Apr
Temperature indicator for aircraft engines, Koletsky .....129 Nov
Temperature stabilizing transistor amplifier .....174 May
Terminals, production techniques
Universal holding jig for terminal boards .....242D May
Testing, see also measurement, ultrasonics
Testing airborne electronic components, Mintz & Levine.....141 Mar
Testing, analyzer for servos.....172 Apr
Testing color tv, differential gain..114 Aug
Testing, transmission gain.....146 Dec
Testing techniques
Accelerator tests parts whirling at 100 g .....322D Mar
Automatic tester for ferrite memory cores .....244D Dec
Calibrating waveguide frequency meters in batches of eleven.....208D Jul
Drop test for instruments, McCormick .....258D Sept
Gap gage for coaxial tuned stub..268D Feb
Illuminated magnifier aids inspection of missile controls.....256D Jan
Life test setup.....234D Nov
Locating heater shorts.....264D Dec
Mechanized line inspects and tests speaker magnets .....226D Jun
Pictorial inspection records expedite flow of quality data, Squires..234D May
Quality control panel shows variations in tested parts.....208D Aug
Recorder checks linearity of precision potentiometers .....244D Nov
Rotating bolt actuates shake table 278D Mar
Rotational life-tester .....262D Nov
Servo amplifier tester for production use, Alman .....310D Mar

Test sets heat plant.....308D Mar
Testing seals of coaxial cavities..257D Jan
Transparent covers for quality control charts.....230D Jun
Turntable aids inspection.....286D Apr
Value-averaging device.....246D Jun
Testing uhf dx.....200D Dec
Theory for formation of thunderstorm electricity.....184D Apr
Thermometer for aircraft engines..129 Nov
Thickness gage, eddy current plating.....146 Nov
Thread-mutilating tool.....256D Sept
Threefold gain in military telephone channels.....180D Apr
Thunderstorms, formation of static electricity.....184D Apr
Thyratron, see also tube
Thyratron relay, microampere.....172D Dec
Time delay generator, nonlinear..194D Nov
Time delay generator.....148 Dec
Time delay networks.....176 Jun
Time delay nomograph.....178 Apr
Time delay, precision.....218D Nov
Time signals, Canadian observatory broadcast.....182D, 196D Jun
Timer for electron microscope.....206 Mar
Timer, short-interval.....168 May
Tiny tube amplifies uhf-tv.....176D Nov
Tone calling, mobile radio.....144 May
Tones, audio, for refinery control...130 Jan
Tones control a-m and f-m stations.132 Sept
Tower, antenna, installation of f-m antenna on a-m.....130 Aug
Tracing electron paths (reference sheet), Spaven.....174 Jun
TRADIC computer uses transistors.222D May
Traffic, radar speed meters.....132 Dec
Traffic, radio control.....194D Jun
Transducer, capacitive, low-impedance.....161 Jun
Transducer, single-tube capacitance.....182D Oct
Transducer tube changes signals to letters.....182D May
Transformer, dielectric, for X-band..146 Dec
Transformer, design of i-f transistor.156 Aug
Transient, trigger adapter for oscillogram recording.....159 Apr
Transients, eliminated from electronic switch.....162 Oct
Transistor amplifier, feedback-stabilized.....174 May
Transistor amplifier performance, Williams.....196D Feb
Transistor amplifiers for analog computers, Ettinger.....119 Jul
Transistor choppers for stable d-c amplifiers, Bright & Kruper.....95 Apr
Transistor circuits, d-c.....122 Jun
Transistor counter, silicon.....112 Aug
Transistor c-r tube deflection circuit, Taylor & Moore.....146 Jul
Transistor, design of portable using.159 Mar
Transistor, junction, switching circuits.....148 Jan
Transistor microphonics.....206D Sept
Transistor modulator for flight trainers, Ettinger.....126 Sept
Transistor pulse generators, Eckess, Deavenport & Sherman.....132 Nov
Transistor receiver, Japanese.....174D Dec
Transistor transformer, design of i-f.156 Aug
Transistorized f-m signal generator, Hupert & Szuhski.....133 Feb
Transistors generate multiwaveforms, Keonjian and Suran.....138 Jul
Transmission, extended range uhf.....182D May
Transmission line calculator, vhf....168 Dec
Transmission test set, Chinski.....145 Dec
Transmitter, see also broadcast
Transmitter, fifty-kw broadcast....168 Mar
Transmitter monitor, color-burst....149 May
Transmitter, multiplexing f-m.....148 Oct
Transmitter, pulsed tone controlled.132 Sept
Transmitter, series-tube modulator..158 Nov
Transmitter, ssb, linear power amplifier.....124 Aug
Transmitter using frequency synthesizer.....138 Jan
Transmitting, matrixing and encoding color television.....140 Nov
Transoceanic telephone cable has built-in repeaters.....178D Sept
Trays, for production use
Assembly-line benches are loaded from rear, Prince & Mowil....262D Apr
Deep-well bins hold precut leads on tv assembly line.....268D Mar
Fibreboard tote boxes for parts use beer-case construction.....240D Feb
Heater-storing trays.....282D Apr
Trigger adapter for transient oscillograms, Fleming.....159 Apr
Triode oscillator, microwave.....184 Mar
Triple-crystal filter.....166 Dec
Tristimulus computer.....166 Oct
Tube, anode-dynode amplifier.....132 Aug
Tube, binary adder.....161 Sept
Tube, colorimeter for color television.....138 Dec
Tube, dark-trace, with infrared erasure.....170 Feb
Tube, dynamic characteristics of triode-connected pentodes.....268D Dec
Tube, flat cathode-ray.....241D Mar
Tube, flat cathode-ray.....186D Nov
Tube, high-power uhf-tv.....120 Apr
Tube, modulated klystron.....186D Jan
Tube Production Techniques
Air-actuated machine makes cat-whiskers for germanium wafers.....210D Aug
Automatic aluminizer for television picture tubes.....236D Jun
Burn-in rack cuts early tube failures, Richards.....300D Mar
Cam-action grid former.....298D Mar
Cathode-shaving tool.....284D Apr
Centering fixtures for color TV picture tubes.....296D Mar
Detecting cracks in glass-to-metal seals, Staats.....284D Mar
Drill-press extrusion of grids for tubes.....250D Jun
Electrode-centering jig.....237D Jul
Filament-inserting funnel.....256D Nov
Flexible drying rods prevent tube breakage.....266D Feb
Lint control program reduces tube rejects.....220D Aug
Pressurized tube plant.....258D Feb
Producing formed and inside-out grids for uhf pencil tubes, Ackerman.....270D May
Round-robin noise test for tubes.244D Apr
Sliding-average computer for tube quality charts.....276D Mar
Soldering crystal diodes.....294D Mar
Trenches replace pipes in tube plant.....238D Jul
Tube-aging conveyor.....260D Oct
V-shaped trough aids threading of cathodes for electropolishing..266D Mar
Tube replaced by plug-in rectifier..198D Aug
Tube socket spreaders.....224D Jul
Tube, storage, secondary emission..141 Jan
Tube, vibrating-ignitor rectifier..248D Mar
Tubes, effect of intense sound on.....196D Feb
Tunable cavity for X-band oscillators, Spencer.....135 Jan
Tunable microwave triode oscillator.184 Mar
Tuning aircraft antenna by a-m system.....152 Aug
TV, see television
Tweeks, ionospheric disturbances..198D May
Twenty-five years of electronics, Zeluff & Arnold.....124 Apr
Two-terminal push-pull oscillator, Cuddy.....202D Aug
Two way radio, improving audio..190D Oct
Two-way uhf pack set uses helmet antenna, Jensen & Schwartz.....150 Mar

U

UHF, amplifier tube for.....176D Nov
UHF antenna for aircraft carrier...174D Dec
UHF, designing components for..186D May
UHF, forward scatter extends range.122 Oct
UHF, grid-control tube.....130 Apr
UHF radio, military pack set.....150 Mar
UHF multiplexer uses selective couplers, Carlin.....152 Nov
UHF rebroadcasting cuts cost, Root.131 May
UHF, testing dx.....200D Dec
UHF transmission, extended range.182D May
UHF-TV, booster amplifier for.....112 Jul
UHF wideband amplifier for receivers.....158 Dec
Ultrasonic alarm system, design of.196 Aug
Ultrasonic irradiation substitutes for lobotomy.....164D Jul
Ultrasonic phase meter measures water velocity, Stuil.....128 Sept
Ultrasonic ranging speeds cancer diagnosis, Reid & Wild.....174 Mar
Ultrasonic switch aids diversity reception, Montgomery.....169 Nov
Underwater television camera hovers or cruises.....174D Sept
Unitized production benches facilitate assembly-line changes.....232D May

V

VHF direction finder.....168D Jul
VHF transmission line calculator, Sanderson.....168 Dec
Vacuum gage, power supply for...210D Feb
Vacuum tube, see tubes
Van de Graaff generator, current regulator for.....151 Oct
Van de Graaff generator, insect control using.....202D May
Variable index of refraction lens for microwave.....142 Aug
Variable-speed control for integral-hp motors, Cowie & Gregson.....162 Apr
Velocity measurement, phase meter for water.....128 Sept
Velocity of propagation, higher...180D Sept
Vibrating-ignitor tube consumes less power, Hatta and Hiraga.....248D Mar
Video, see also television
Video amplifier for color television..154 Mar
Video patch panel using r-f connectors, Weise.....210D Apr
Volscan evaluation.....206D Dec
Voltage current curve sawtooth pulser for.....156 Dec
Voltage divider, digital.....176D Dec
Voltmeter, expanded scale a-c.....164 Dec
Voltmeter, square law detector for rms.....170 Nov

W

Water-dip solution cleans terminals.....254D Nov
Water velocity, phase meter for.....128 Sept
Waveform generator, transistor.....138 Jul
Waveform generator uses pulse techniques, Newhall.....149 Jun
Waveguide, see also microwave
Waveguide, dielectric transformer for X-band.....146 Dec
Waveguide, long distance.....212D Mar
Waveguide, nomographs for rectangular.....172 Jan
Waveguide, reflection-type asymmetrical.....192D Dec
Waveshape generator, high voltage.....222D Apr
Weather map recorder.....196D Jul
Weather mapping radar uses C-band.....178D Sept
Weather warnings.....202D Feb
Weighing, electronic production....162 Jun
Whistlers, ionospheric disturbances.....198 May
Wide-angle phase shifter for industrial controls, Brown.....188 Mar
Wide-band amplifier.....154 Jul
Wide-band amplifier for uhf receivers, McWhirt.....158 Dec
Wide-band analog function multiplier, Miller, Soltes & Scott.....160 Feb
Wings on chassis support 24-inch picture tube.....248D Sept
Wire insulation, controlling extrusion of.....144 Apr
Wire Production Techniques
Beveling new pliers prevents nicking of wires.....267D Jan
Card-controlled machine makes wrapped joints.....224D Nov
Constant-tension automatic wire-twisting machine.....220D Oct
Cutting plastic sleeving.....248D Jan
Grounding shield braid in guided missiles.....240D Apr
Induction generator bonds hookup wire strands before stripping..208D Aug
Lead length gage.....264D Sept
Linotype slugs identify wires....236D Nov
Minimizing splices in aircraft radio panel.....272D Apr
Potting Techniques for Cable Connectors.....230D Jan
Precision photoelectric wire-cutting machine.....252D Feb
Pulling cable conductors through plastic sleeve.....238D Jan
Spring clips on harness board serve as wire-cutting guides.....222D Jan
Stripping nylon jacket from shielded wire.....270D Feb
Terminal and marking tools added to wire cutter.....258D Dec
Tin reflowing cuts wire-stripping costs.....242D Nov
Waterproofing cable connectors..250D Feb
Wire-coiling dish.....226D Nov
WOR master control.....204D Sept
WOR-TV, Empire State antenna...214D Apr

X

X-band receiving amplifier, Ishii..202D Apr
X-ray television shows inside of operating engine.....182D Apr

Z

Zener-voltage breakdown uses in silicon diodes, Wulfsberg.....182D Dec
Zero hysteresis relays, Barditch....202D Dec

AUTHOR INDEX

Items in the author index for which page references are preceded by (letter) are comments from readers, published monthly in the Backtalk department

A

Abel, F., Adams, Alford, Leach & Rubin, Empire State antenna for WOR-TV .....214D Apr
Ackerman, H. J., Producing formed and inside-out grids for uhf pencil tubes .....270D May
Adams, G. J., Alford, Leachm Rubin & Abel, Empire State antenna for WOR-TV .....214D Apr
Alexander, F. C., Jr., About whistlers (letter) 380D Aug
Alford, A., Leach, Rubin, Abel & Adams, Empire State antenna for WOR-TV .....214D Apr
Alman, J., Servo amplifier tester for production use .....210D Mar
Applegarth, A. R., Airborne interrogator spots location .....170 May
Armstrong, H. L., Infinite impedance detector-amplifier .....168D Aug
Arnold, W. G. & Zeluff, 25 years of electronics .....124 Apr

B

Backman, K., Mobile power supply for 6 and 12 volts .....216D May
Bagno, S. S., Designing ultrasonic alarm systems .....196 Aug
Baker, V. H., Taboada & Wiant, Insect control by electron irradiation 202D May
Barditch, I., Electronic chopper for d-c amplifiers .....192D Nov
Barditch, I., Zero hysteresis relays.202D Dec
Barnette, W. E. & Giacoletto, Differential amplifier for null detection 148 Aug
Barry, J. N. & Clarke, Microwave modulator uses ferrite gyrator...139 May
Beckwith, H., Flip-flop counter has extended range .....149 Jan
Begun, S. J., Magnetic tape improves geophysical recordings .....152 Jan
Bell, R. E. & Ferstle, Electronic weighing on the production line..152 Jun
Bernard, W. B., Distortion correction (letter) 480D Mar
Bernard, W. B., Series tube modulates amplifier screen-grid.....158 Nov
Berry, C. E., Noise calculations (letter) 409D May
Beter, R. H., Bradley, Brown and Rubinoff, Directly coupled transistor circuits .....132 Jun
Bibbero, R. J. & Krakauer, Modular simulator tests missile radar.....127 Jul
Bishop, F. W., Exposure timer for the electron microscope .....206 Mar
Bivans, E. W., Synchronizing magnetic drum storage speed .....140 Aug
Blake, R. F. & Morgan, Delay line subcarrier discriminator .....203 Mar
Blois, M. S., Jr., Evaporated magnetic materials .....210D Jun
Boesen, G. F. & Schults, Juke box uses ferrite-core memory .....138 Oct
Bose, J. H., Multiplexing f-m broadcast transmitters .....146 Oct
Bower, G. E. & Wynn, Antenna system for missile telemetering .....164 Jun
Bradley, E. H., Microstrip lines (letter) 322D Jul
Bradley, E. H. & White, Band-pass filters using strip-line techniques 152 May
Bradley, W. E., Brown, Rubinoff & Beter, Directly coupled transistor circuits .....132 Jun
Brantley, J. Q., How accurate are radar speed meters? .....132 Dec
Braun, E. H., Bias supply design for bolometers .....208D Oct
Bright, R. L. & Kruper, Transistor choppers for stable d-c amplifiers 135 Apr
Broida, H. P. & Gilford, Physiological monitor for anesthesia .....130 Oct
Brown, A. C. L., Recording and tabulating the radio-tv audience .....126 Jan
Brown, R. B., Rubinoff, Beter & Bradley, Directly coupled transistor circuits .....132 Jun
Brown, W. J., Wide-angle phase shifter for industrial controls.....138 Mar
Brueckmann, H., Helicopter measures antenna patterns .....134 Nov
Bruene, W. B., Linear power amplifier for ssb transmitters .....134 Aug
Buesing, R., Improving audio quality of mobile radio.....190D Oct
Burnett, L. C., Fast tube rate (letter) 408D May
Burr, R. P. & White, Simple color computer gives tristimulus values 166 Oct
Burris, F. J., Reactance voltage bias source .....218D Feb
Buss, R. R. & Hetland, Low-ripple adjustable regulated power supply 164 Nov

C

Cambrill, R. D., Controlling extrusion of foam plastic on wire.....144 Apr
Carlin, H. J., UHF multiplexer uses selective couplers .....152 Nov
Carroll, J. M., Electronic computers for the businessman .....122 Jun
Cass, W. R., Double-dip soldering uses chassis vibrator .....226D Dec
Chalfin, N. L., Pertinent patents..210 Jan 222D Feb, 256D Mar, 226D Apr 196D Jul, 206D Sept
Chase, C. E., Direct-reading noise-figure indicator .....161 Nov
Chen, T. S., Nomographs for rectangular waveguides .....172 Jan
Chinski, G. R., Transmission test set .145 Dec
Christensen, H. & Funder, Pressure gage for ship-model hulls.....196D Jan
Clarke, W. W. H. & Barry, Microwave modulator uses ferrite gyrator 139 May
Colby, N. C., Designing 2,000-mc components for communications ....186D May
Cole, E. B., Jr., Airplane models reveal how to avoid radar .....122 Jan
Coleman, E. F., Potentiometer design for minimal loading .....184D Feb
Cologne, K. M. & Marriner, Sonar target simulator .....167 Mar
Conover, W. B., Microphone nomograph (reference sheet) .....172 Oct
Cowle, E. G. & Gregson, Variable-speed control for integral-hp motors .....162 Apr
Cuddy, E. J., Two-terminal push-pull oscillator .....202D Aug

D

Davidson, D. & Pote, Designing overhorizon communications links.....126 Dec
Davis, H. G., Jr., Medical electronics and custom construction ..(letter) 340D Jan
Davis, R. H. & Lion, Square-law circuit .....192D Sept
Day, J. R., Beyond-horizon signals extend communications .....122 Oct
Deavenport, J. E., Sherman & Eckness, Transistor pulse generators..132 Nov
Deichert, R. W., Regulator for constant current power supplies....170D Aug
Demars, S. A., Jones & Thomas, Automatic damping improves tv monitor .....230D Mar
Deming, C. R., Amplifier for fast rise-fall pulses .....170 Sept
Dessler, A. J. & Robinson, Dynamic characteristics of triode-connected pentodes .....208D Dec
De Vore, C., More early radar (letter) 382D Jun
Diamond, J. M., IM or idp curves (letter) 359D Jan
Dickey, F. E., Servo analyzer for wide-range testing .....172 Apr
Donner, W., Acknowledgement ...410D May
Donner, W., Spectrometer regulator stabilizes r-f .....137 Nov
Donner, W., Tape-controlled servos speed chemical analysis .....136 Feb
Downie, E. G., Magnetic frequency multiplier for fluorescent lighting 224D May

E

Eakin, J. H., Resonant-loop antenna for vhf direction finding .....172 Feb
Eckess, W. E., Deavenport & Sherman, Transistor pulse generators..132 Nov
Emslie, N. M., Basic chassis for experimental work .....166 Nov
Epstein, J., Morrison & Woodward, Extending uhf-tv with booster amplifiers .....112 Jul
Ettinger, G. M., Transistor amplifiers for analog computers .....119 Jul
Ettinger, G. M., Transistor modulator for flight trainers .....126 Sept

F

Fearon, E. T., Automatic micrometer sorts insulating wafers.....156 May
Feldheim, F. S., Gamble & Godwin, Punched cards control job-lot assembly system .....122 Nov
Ferstle, J. A. & Bell, Electronic weighing on the production line..152 Jun
Fleming, L., Fixed LC oscillator without taps .....216D Mar
Fleming, L., Single-tube capacitance transducer circuit .....182D Oct
Fleming, L., Trigger adapter for transient oscillograms .....158 Apr

Fleming, L. & Follin, Subaudio oscillator tunes 0-50 cycles .....144 Oct
Follin, W. W. & Fleming, Subaudio oscillator tunes 0-50 cycles.....144 Oct
Fox, R. C., Embedding technique for three-tube plug-in unit .....250D May
French, H. & Kennedy, Color-video envelope-delay measurement .....144 Jun
Froemke, D. & Nelson, Electronic load 216D Nov
Funder, J. E. & Christensen, Pressure gage for ship-model hulls..196D Jan

G

Galman, H., Expanded scale voltmeter for a-c measurements .....164 Dec
Gamble, G. W., Godwin & Feldheim, Punched cards control job-lot assembly system .....122 Nov
Geiser, D. T., A-M system tunes aircraft antennas .....152 Aug
Geist, J. C., Automobile reflection in vhf-tv .....166D Jul
Giacoletto, L. J. & Barnette, Differential amplifier for null detection 148 Aug
Gilford, S. R. & Broida, Physiological monitor for anesthesia .....130 Oct
Giovanelli, R. G., Photometer tests reflecting road signs.....204D Feb
Goatley, C. & Kelleher, Dielectric lens for microwaves .....142 Aug
Godwin, C. J., Feldheim & Gamble, Punched cards control job-lot assembly system .....122 Nov
Goldberg, H. B., Local oscillator for c-w radars .....166 May
Gottlieb, I., Gas glow potentials (letter) 483D Mar
Gregson, J. H. & Cowie, Variable-speed control for integral-hp motors .....162 Apr
Grisamore, N. T. & Uyehara, Pulse-series generator .....224D Mar
Groenendyke, G. M. & Loper, Cathode-ray display of seismic recordings 160 May
Gruner, R. A., Another staple technique .....(letter) 410D May

H

Hahnel, A., Phase-controlled multichannel oscillator .....164 Apr
Hargreaves, W. V., Jr., Compensated squelch for mobile radio receivers 142 Jul
Hariharan, M., Ideal world..(letter) 380D Feb
Harris, J. N., Sensitive thyratron relay operates on microampere .....172D Dec
Hassel, E. W., Single-tone calling simplifies mobile radio.....144 May
Hatta, Y. & Hiraga, Vibrating-ignitor tube consumes less power.....248D Mar
Heasley, C. C., Jr. & Shepard, Photoelectric reader feeds business machines .....134 May
Heath, W. T. & Lufcy, Alloy improves magnetic recording .....137 Jun
Hetland, O., Jr. & Buss, Low-ripple adjustable regulated power supply 164 Nov
Heywood, J. P., Quality control charts for printed wiring .....216D Jul
Hildreth, D. E., Staggered triple-crystal filter .....166 Dec
Hilliard, J. K. & Noble, Low-noise input stage for audio preamplifier 147 Feb
Hind, J. E. & Ludwig, Electronic switch eliminates transients .....163 Oct
Hiraga, S. & Hatta, Vibrating-ignitor tube consumes less power.....248D Mar
Hodowanec, G. & Holborn, Infrared speeds erasure of dark-trace tubes 170 Feb
Hogan, J. V., Facsimilie speedup enhances usefulness .....134 Jul
Holborn, F. & Hodowanec, Infrared speeds erasure of dark-trace tubes 170 Feb
Holmes, H., Light hydraulic presses cut phono pickup costs.....250D Jan
Hooper, E. T. & Suozzi, All-magnetic audio amplifier .....122 Sept
Houghton, R. W., Phase meter analyzes color tv systems.....156 Jan
Huie, J. A., Power rating of parasitic suppressors (reference sheet).....170 Oct
Hupert, J. J. & Szubski, Transistorized f-m signal generator .....132 Feb

I

Isborn, C. & Swarthe, Counting labels with ferroresonant rings.....128 Oct
Ishii, K., Reflection-type asymmetrical waveguide .....192D Dec
Ishii, K., X-band receiving amplifier 202D Apr
Ivers, J. H. & Sheehan, Design of transistorized high-gain portable..169 Mar
Ives, R. L., Ferrule wrench aids mounting of panel lamps.....213D Jul
Ives, R. L., Nut starters.....236D Jul

J

Jensen, D. C. and Schwartz, Two-way uhf pack set uses helmet antenna 150 Mar
Jensen, G. K. & McGeogh, Four-decade frequency divider.....154 Apr
Jiu, R., Relay contact bounce measurements .....137 Aug
Joffe, M., Meter shows color-burst deviation .....149 May
Jones, M. E., Thomas & Demars, Automatic damping improves tv monitor .....230D Mar

K

Kaiser, A. W. & Wolkstein, Anode-dynode beam deflection amplifier 132 Aug
Kalmus, H. P., Capacitance transducer has low impedance.....161 Jun
Kamm, L. J., Digital voltage divider using four resistors .....176D Dec
Kanagy, M. T., All-magnetic a-f amplifier .....(letter) 406 Nov
Kaufman, A. B., Pot design problem (letter) 408D May
Kaufman, B. A., Nonlinear time-delay generator uses diodes .....194D Nov
Kelleher, K. S. & Goatley, Dielectric lens for microwaves .....142 Aug
Kennedy, R. C. & French, Color-video envelope-delay measurement 144 Jun
Keonjian, E. & Suran, Transistors generate multiwaveforms .....128 Jul
Kiebert, M. V., Jr., Circuit design factors for audio amplifiers .....166 Apr
Kleist, L., Rotational life-tester...262D Nov
Klink, G., Jr., F-M antenna inside the a-m tower .....130 Aug
Klivans, L. S., Basic control circuits are packaged .....122 Dec
Koletsky, H., Temperature indicator for aircraft engines .....129 Nov
Koros, L. L., High-power uhf-tv uses grid-control tube.....130 Apr
Koustas, P., Audio-standard generator 161 Dec
Krakauer, M. & Bibbero, Modular simulator tests missile radar.....127 Jul
Krenitsky, P., Decade counter employs silicon transistors .....112 Aug
Kruper, A. P. & Bright, Transistor choppers for stable d-c amplifiers 135 Apr

L

Leach, H. H., Rubin, Abel, Adams & Alford, Empire state antenna for WOR-TV .....214D Apr
Lee, R., Linear reactor chart.....208 Mar
Leng, R. B., Controlling dust in microwave tube assembly plant.....238D Apr
Levin, J. B., Portable precision approach radar .....154 Oct
Levine, M. B. and Mints, Testing airborne electronic components .....181 Mar
Linden, D. L., Chassis design for i-f amplifiers .....182D Aug
Lindner, M., More pot data .....(letter) 377D Apr
Lion, K. S. & Davis, Square-law circuit .....192D Sep
Lippke, J. A., Drafting aid..(letter) 379D Feb
Longo, C. V. & Wolf, R-F filter design (reference sheet) .....176 Feb
Loper, G. B. & Groenendyke, Cathode-ray display of seismic recordings..160 May
Lovell, W. V., Electromagnet removes nonferrous metals .....164 Sep
Ludwig, H. & Hind, Electronic switch eliminates transients .....163 Oct
Lufcy, C. W. & Heath, Alloy improves magnetic recording .....137 Jun
Lux, W., German tv transmitters (letter) 482D Mar

M

Markowitz, J., Electronic organ uses rotating loudspeakers .....116 Jul
Markus, J., Mechanized production of electronic equipment .....137 Sep
Marriner, E. H. & Cologne, Sonar target simulator .....167 Mar
Martin, L. J. & Vavra, Controlling sludge in etched wiring bath.....234D Nov
Martin, L. J. & Vavra, Controlling eyelets in etched wiring.....250D Dec
Maynard, F. B., Binary-adder tube for high-speed computers .....161 Sep
McCarrell, S., Noise factor nomograph (reference sheet) .....174 Nov
McCormick, E. M., Data reduction system for missile telemetering..126 May
McCormick, S. T., Drop test for instruments .....258D Sep
McCusker, R. W., Producing oscillations with a Colpitts circuit.....184D May
McDuffie, T. E., Spectrum analyzer for quartz crystals .....160 Oct
McFolin, R. L. & Sclar, Sawtooth pulser gives voltage-current curves.....166 Dec
McGeogh, J. E. & Jensen, Four-decade frequency divider .....154 Apr
McGhee, R., Review revised (letter) 319D Jul
McKenzie, A. A., Getting the most from mobile radio.....156 Jun
McLaughlin, J. L. A., Dynamic receiver selectivity .....128 Feb
McWhirt, R. B., Wide-band amplifier for uhf receivers .....158 Dec
Merrill, J. L., Smethurst & Rose, Repeater amplifies in either line direction .....164 Jan
Michels, H., Pulsed tones control a-m and f-m stations .....132 Sep
Miessner, B. F., Paten' bill pending (letter) 218D Jul
Miessner, B. F., Those early days (letter) 285D Sept
Milek, J. T., Market for electronic equipment .....138 Apr
Miller, J. A., Soltes & Scott, Wide-band analog function multiplier..160 Feb
Millman, J. & Taub, Cathode compensation linearizes video stages .....156 Nov
Mints, F. & Levine, Testing airborne electronic components .....181 Mar
Moerman, N. A., Short-interval timer 168 May
Montgomery, C. F., Ultrasonic switch aids diversity reception .....169 Nov
Moore, G. M., Impulse magnetizer for permanent magnets .....121 Aug
Moore, T. M. & Taylor, Transistor c-r tube deflection circuit .....146 Jul
Morgan, K. A. & Blake, Delay line subcarrier discriminator .....202 Mar
Morrison, H., Criss-cross d-c amplifier .....198D Aug
Morrison, W. C., Epstein & Woodward, Extending uhf-tv with booster amplifiers .....112 Jul
Mowll, J. U. & Prince, Assembly-line benches are loaded from rear 242D Apr
Mural, F., Dynamic-diode limiter for f-m demodulators .....146 Aug

N

Nelson, V. R. & Froemke, Electronic load .....216D Nov
Newhall, E. E., Waveform generator uses pulse techniques .....149 Jun
Nicholson, W. Q. & Ross, Kerr-cell shutter has submicrosecond speeds 171 Jun
Nilsen, P. J. & Tufte, Comparator for small phase angles .....188D Jan
Noble, J. J., Noise calculations (letter) 409D May
Noble, J. J. & Hilliard, Low-noise input stage for audio preamplifier..147 Feb
Norris, K. H., Photoelectric inspector detects green rot in eggs .....140 Jul

O

Olin, I. D., Dielectric transformers for X-band waveguide .....146 Dec

P

Papian, W. N., New ferrite-core memory uses pulse transformers .....194 Mar
Park, F. R., Microwave system controls fog alarm .....122 Jul

Pastor, J., Jr., Staple problem (letter) ....480D Mar
Persley, W., Precision digital delay generator ....148 Dec
Plemenos, F. A., Repetition-rate generator has high accuracy ....148 Nov
Porter, J. H., Sensitive limit detector ....202D Oct
Pote, A. J. & Davidson, Designing over-horizon communications links....126 Dec
Prince, W. & Mowll, Assembly-line benches are loaded from rear...262D Apr
Prugh, T. A., Junction transistor switching circuits ....168 Jan

R

Rabinow, J., Scanning disk improves auto headlight dimmer ....170 Mar
Rabinowitz, J., Schacher, Star & Taub, Matrixing and encoding color for telecasting ....140 Nov
Raible, R. W., Testerman & Sloan, Highly regulated r-f voltage supply ....192D Apr
Raible, R. W. & Testerman, Ion-gage supply protects tubes ....210D Feb
Reed, J. M., High-voltage waveshape generator ....232D Apr
Reid, J. M. & Wild, Ultrasonic ranging speeds cancer diagnosis ....174 Mar
Richards, J. A. K., Burn-in rack cuts early tube failures ....300D Mar
Richardson, R. L., Precise measurement of sawtooth linearity....204D Nov
Riddle, R. L., High fidelity transistor power amplifier ....174D Sep
Robberson, E., How to design sailboat antennas ....140 Jun
Robinson, H. G. & Dessler, Dynamic characteristics of tridode-connected pentodes ....308D Dec
Rockett, F., Metallic rectifiers approach infinite life ....162 Mar
Rockett, F., New delay materials improve performance ....144 Jan
Rockett, F., Special-purpose relays gain new uses....150 Feb
Rogers, E. J., Current regulator for van de Graaff bagnet....151 Oct
Roman, R. J., Modular bundles use etched-wiring boards ....230D Dec
Romander, H. & Watson, Navy transmitter uses frequency synthesizer ....136 Jan
Root, H. G., UHF rebroadcasting cuts costs ....131 May
Rose, A. F., Merrill & Smethurst, Repeater amplifies in either line direction ....164 Jan
Rosenberg, R. S., High-quality receiver for tv rebroadcasting....152 Dec
Ross, I. & Nicholson, Kerr-cell shutter has submicrosecond speeds....171 Jun
Roth, J., Automatic music-speech discriminator silences speaker ....162D Aug
Rubin, R., Abel, Adams, Alford & Leach, Empire state antenna for WOR-TV ....314D Apr
Rubinoff, M., Beter, Bradley & Brown, Directly coupled transistor circuits ....132 Jun
Rudenberg, H. G., Silicon power rectifiers for a-c line operation ....146 Apr

S

Sanderson, A. E., VHF transmission line calculator ....168 Dec
Sauber, J. W., Square-law detector for rms voltages ....170 Nov
Savant, C. A. & Savant, Electromechanical networks for a-c servo-systems ....190D Feb
Savant, C. A. & Savant, Notch network design (reference sheet)..172 Sept
Savant, C. J., Jr., & Savant, Notch network design (reference sheet)..172 Sept
Schacher, D., Star, Taub & Rabinowitz, Matrixing and encoding color for telecasting ....140 Nov
Scheidorf, M. W. & Klink, F-M antenna inside the a-m tower ....130 Aug
Schlesinger, K., Phase measurement for color tv and f-m ....142 Feb
Schrock, J. B., Launching control for guided missiles ....122 Feb
Schroeder, J. O., Differential gain set tests tv color....114 Aug
Schroeder, J. O., Studio amplifier design for color television ....154 Mar
Schultz, C. W. & Roesen, Juke box uses ferrite-core memory....138 Oct
Schwartz, M. & Jensen, Two-way uhf pack set uses helmet antenna ...150 Mar
Sclar, N. & McFolin, Sawtooth pulser gives voltage-current curves....156 Dec
Scott, R. E., Miller & Soltes, Wideband analog function multiplier..160 Feb
Selter, J. G., Vacuum metallizing of selenium rectifiers ....258D Nov
Shuraf, H. M., Automatic recorder for complex impedances ....167 Sept
Sheehan, W. E. & Ivers, Design of transistorized high-gain portable ....159 Mar
Shepard, D. H. & Heasly, Photoelectric reader feeds business machines...134 May
Shepard, W. L., One-man tv camera aligner ....214D Dec
Sherman, K. I., Eckess & Deavenport, Transistor pulse generators ....122 Nov
Shuck, L. M., Jeeps and electrons (letter) 399D Oct
Sinish, R. D., Precision calibrator checks radar beacons ....150 Apr
Sion, E., Dielectric mixture chart (reference sheet) ....176 Apr
Sixbey, S. R. & Weiss, Target discriminator for countermeasures...118 Aug
Slaughter, D. W., Feedback-stabilized transistor amplifier ....174 May
Slayton, W. T., Design of microwave gain-standard horns ....150 Jul
Sloan, L. G., Raible & Testerman, Highly regulated r-f voltage supply ....192D Apr
Smaller, P., Automatic programming cuts broadcasting costs ....135 Oct
Smethurst, J. O., Rose & Merrill, Repeater amplifies in either line direction ....164 Jan
Sodaro, J. F., Delay-line design (reference sheet) ....176 Jun
Sodaro, J. F., Phase-linearity nomograph (reference sheet) ....178 Apr
Soltes, A. S., Scott & Miller, Wideband analog function multiplier..160 Feb
Sommers, D. J., Photoetched antennas for supersonic aircraft ....130 Jul
Spaven, W. J., Tracing electron paths (reference sheet) ....174 Jun
Spencer, M. C., Squirrel-cage motor speed control system ....126 Aug
Spencer, N. A., Tunable cavity for X band oscillators ....135 Jan
Squires, P. H., Pictorial inspection records expedite flow of quality data ....224D May
Squires, W. K. & Wendt, Feedback clamp circuit for tv....182D Jul
Staats, H. N., Detecting cracks in glass-to-metal seals ....284D Mar
Stanford, E., Automatic colorimeter for tv color tubes ....138 Dec
Star, M., Taub, Rabinowitz & Schacher, Matrixing and encoding color for telecasting ....140 Nov
Stephenson, J. G., Designing stable triode microwave oscillators ...184 Mar
Stineheifer, H. E., Sr. & Vogler, Industrial microwave calibrator ....168 Jun
Storm, H. F., Four decades ago (letter) ....277D Apr
Struven, W. C., Precision time-delay ....218D Nov
Stull, K. S., Jr., Ultrasonic phase meter measures water velocity....128 Sept
Sulzer, P. G., Audio oscillator has low distortion ....158 May
Suozzi, J. J. & Hooper, All-magnetic audio amplifier ....123 Sept
Suran, J. J., Double base expands diode applications ....198 Mar
Suran, J. J. & Keonjian, Transistors generate multiwaveforms ....138 Jul
Swarthe, E. & Isborn, Counting labels with ferroresonant rings ....128 Oct
Szubski, T. & Hupert, Transistorized f-m signal generator ....133 Feb

T

Taboada, O., Wiant & Baker, Insect control by electron irradiation..202D May
Taub, H. & Millman, Cathode compensation linearises video stages..156 Nov
Taub, H., Rabinowitz, Schacher & Star, Matrixing and encoding color for telecasting ....140 Nov
Taylor, J. W., Jr. & Moore, Transistor c-r tube deflection circuit ....146 Jul
Testerman, M. K., Sloan & Raible, Highly regulated r-f voltage supply ....192D Apr
Testerman, M. K. & Raible, Ion-gage supply protects tubes....210D Feb
Thomas, H. E., Aligning tv receivers by pulse-cross display ....184D Apr
Thomas, H. E., Demaris & Jones, Automatic damping improves tv monitor ....230D Mar
Thurston, E. G., Ice detector for lighter-than-air craft ....142 Dec
Tooke, P. E., Counting circuit batches components ....157 Feb
Traugott, P., More medical electronics (letter) 382D Jun
Trinter, V. E., Fan-pencil antenna for search radars ....142 May
Tufte, R. & Nilsen, Comparator for small phase angles ....188D Jan

U

Uhlmann, W. E. M., Storage tube employs secondary emission ....161 Jan
Upham, J. L., Jr., Automatic a-c bridges sort ceramic capacitors..106 Jul
Uyehara, G. U. & Grisamore, Pulse-series generator ....234D Mar

V

Van Wambeck, E. H., Audio tones control refinery operations ....130 Jan
Vavra, M. J. & Martin, Controlling sludge in etched wiring bath....238D Nov
Vavra, M. J. & Martin, Substitutes for eyelets in etched wiring....250D Dec
Vogler, J. G. & Stineheifer, Industrial microwave calibrator ....168 Jun

W

Waidelich, D. L., Pulsed eddy currents gage plating thickness ....146 Nov
Watson, R. & Romander, Navy transmitter uses frequency synthesizer..136 Jan
Weber, J. P., Home movie sound (letter) 378D Feb
Webb, H. D., How to design overstaggered doublets (reference sheet) ....158 Jul
Webster, R. R., How to design i-f transistor transformers (reference sheet) ....156 Aug
Webster, R. R., I-F transistor transformers ....(letter) 399D Oct
Weiss, D. M., Video patch panel using r-f connectors ....210D Apr
Weiss, M. & Sixbey, Target discriminator for countermeasures ....118 Aug
Wendt, K. R. & Squires, Feedback clamp circuit for tv....182D Jul
White, D. R. J. & Bradley, Band-pass filters using strip-line techniques ....152 May
White, J. R. & Burr, Simple color computer gives tristimulus values ....166 Oct
Wiant, D. E., Baker & Taboada, Insect control by electron irradiation ....202D May
Wild, J. J. & Reid, Ultrasonic ranging speeds cancer diagnosis ....174 Mar
Williams, C. E., Transistor amplifier performance ....196D Feb
Winningstad, C. N., Generating r-f energy for 6-bev bevatron ....164 Feb
Witty, W. M., Modern fifty-kilowatt broadcast transmitter ....168 Mar
Wolf, E. & Longo, R-F filter design (reference sheet) ....176 Feb
Wolkstein, H. J. & Kaiser, Anode-dynode beam deflection amplifier..132 Aug
Woll, H. J., All-pass amplifier ....155 Jul
Woods, R. W., Electronic switch for biological observations ....135 Dec
Woods, R. W., Improving cathode-follower frequency response ....190D Aug
Woodward, O. M., Jr., Epstein & Morrison, Extending uhf-tv with booster amplifiers ....112 Jul
Wouk, V., High-voltage supply uses electronic filter ....154 Aug
Wouk, V., Lissajous therapy..(letter) 484D Mar
Wulfsberg, K. N., Zener-voltage breakdown uses in silicon diodes....182D Dec
Wynn, J. B., Jr., & Bower, Antenna system for missile telemetering ..164 Jun

Z

Zeluff, V. & Arnold, 25 years of electronics ....124 Apr
Zucchino, M., Autopilot magnetic servo amplifier ....208D May

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If your requirements are complicated and you require more space, we suggest that you write directly to the manufacturer, stating your problem in detail and asking for specific information or assistance. Be sure to include the postcard with your detailed request in order that your inquiry be given prompt and expeditious attention. Make certain that you specify which PRODUCT you are interested in if more than one appears in the advertisement.

electronics

READER SERVICE SECTION

A method that provides readers with a . . .

"DIRECT-TO-THE-MANUFACTURER"

method of obtaining information on:

1. Products advertised in this issue
2. New Products and Literature covered in the editorial section of this issue

This direct method prevents loss of time in remailing your request from publication to manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

HERE IS WHAT YOU DO:

1. Fill in with ink or typewriter your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficient space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled in postcard accompanies your letter.

THIS SERVICE IS A CONVENIENCE FOR THE READERS OF ELECTRONICS.

Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

As described in ad on page ..... of December 1955 Issue

or, Check

New Product		..... on Page .....
Literature		(Name of Product or Literature)

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by telephone. Phone Number.....

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Name .....

Company .....

Address .....

Title .....

Please send me further information on

(Product or Service).....

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ELECTRONICS
December 1955

Place Stamp Here

TO: _____

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December 1955

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December 1955

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TO: _____

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For PRODUCTS and SERVICES

not specifically advertised or described in the issue of Electronics

Consult your

1955-1956 ELECTRONICS BUYERS' GUIDE

or

Write to:

Reader Service Department
Electronics
330 West 42nd Street
New York 36, N. Y.

For The

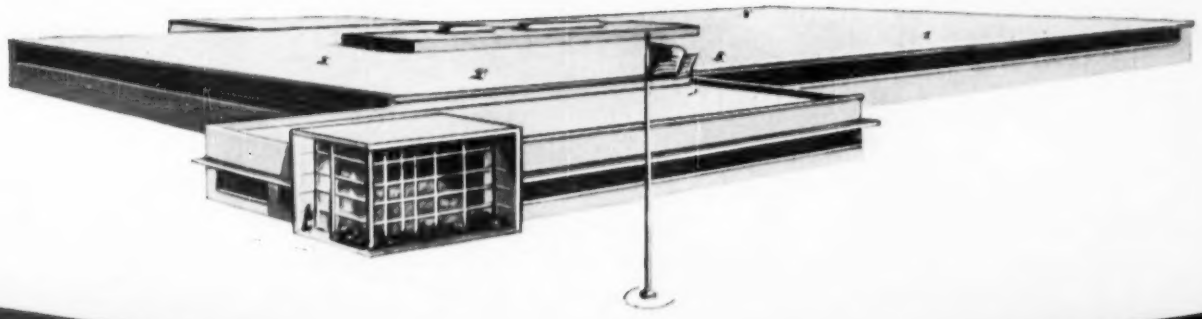
Daven Company

For You: Progress and Service...

...through greatly augmented engineering-research personnel, multiplied production facilities, delivery schedules to meet every deadline, far-reaching engineering assistance and new efficiencies in every department...to enhance Daven's reputation for leadership in the design, manufacture and supply of:

Attenuators · Precision Wire Wound and Metal Film Resistors · Rotary Switches · Electronic Test Equipment

THE MOST MODERN ELECTRONIC COMPONENTS PLANT IN THE WORLD...



THE DAVEN CO.

526 West Mt. Pleasant Avenue, Route 10, Livingston, New Jersey

TODAY, MORE THAN EVER, THE DAVEN (D) STANDS FOR DEPENDABILITY!

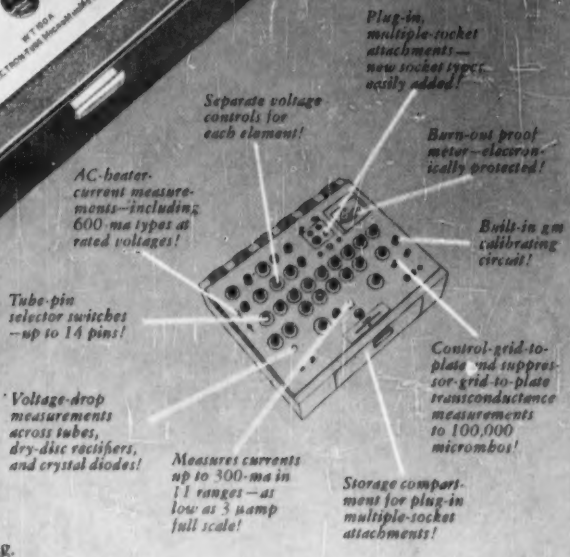
RCA WT-100A Electron-Tube MICROMHOMETER

NEW VERSATILE TUBE TESTER!

RCA-WT-100A
Electron-Tube MICROMHOMETER . . .
Suggested User Price: **$785.00**

Practical for:

- Radio, Phonograph, and TV Set Manufacturers
- Electronic Equipment Manufacturers
- Electronic Research and Development Groups
- Electronic Maintenance and Service Groups
- Communication and Broadcast Stations
- Tube Manufacturers


Plug-in, multiple-socket attachments—new socket types easily added!
Separate voltage controls for each element!
Burn-out proof meter—electronically protected!
AC-heater-current measurements—including 600-ma types at rated voltages!
Built-in gm calibrating circuit!
Tube-pin selector switches—up to 14 pins!
Control-grid-to-plate and suppressor-grid-to-plate transconductance measurements to 100,000 micromhos!
Voltage-drop measurements across tubes, dry-disc rectifiers, and crystal diodes!
Measures currents up to 300-ma in 11 ranges—as low as 5 μamp full scale!
Storage compartment for plug-in multiple-socket attachments!

. . . has accuracy approaching that of tube-factory equipment for measuring true gm

The new RCA-WT-100A Electron-Tube MICROMHOMETER is especially suited for laboratory and production-line testing, and circuit design engineering. Unique design makes possible the testing of receiving tubes, receiving-type tubes for industry and communications, and small transmitting tubes under actual operating voltage and current conditions. This feature permits *direct correlation* of test results *with tube manufacturers' published data*—and, in design work, permits the determination of a tube's performance under a given set of current and voltage conditions. The MICROMHOMETER is manufactured in accordance with the same rigid standards of high quality that account for the outstanding reputation of RCA tubes. The WT-100A weighs only 50 pounds; measures 23½" x 8" x 18½".

No inconvenient patchcords—no external null indicators required! Highly accurate, repeatable measurements! Built-in voltage-regulated power supply provides voltages to 300 volts; provides currents to 300 ma!

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

For descriptive information, call or write your RCA Representative or write Commercial Engineering, RCA, Section L-19-Q Harrison, N. J.